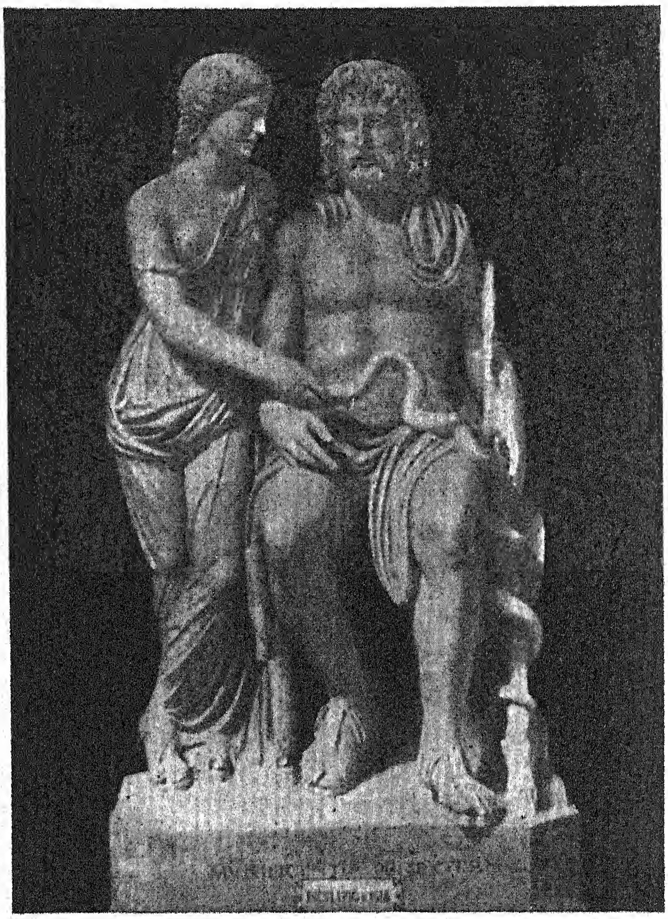

Asclepios, mythical god of healing, and his daughter Hygeia, goddess of health.

Sculptor unknown. The Vatican.

HYGIENE

A TEXTBOOK FOR COLLEGE STUDENTS ON PHYSICAL AND MENTAL HEALTH FROM PERSONAL AND PUBLIC ASPECTS.

BY

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FOREWORD BY

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To

MRS. GEORGE SUMNER WRIGHT

in appreciation of a stimulating friendship

FOREWORD

It is a pleasant privilege to write a foreword for this book, and likewise, to congratulate its author. Dr. Meredith's career in medicine began during the writer's surgical professorship at Tufts Medical School, and the direction of her interests and the progress of her development have been observed with approval and pardonable satisfaction.

The production of a textbook of hygiene, in view of the extent and growth of our knowledge of this subject, is an undertaking today of real magnitude. It is one, however, for which there is a real need, since revelations in the way of further knowledge are constantly occurring.

One has but to mention the development of our knowledge of the pituitary gland, with its various factors, particularly the growth factors, and the gonadotropic, thyrotropic, adrenotropic and diabetogenic factors, and others of apparently less importance. The thyroid, with its relation to iodine, is an example which is well illustrated in the report of Eggenberger at the last International Goiter Congress, at Washington. He reported from the province of Herisau, Switzerland, where ten years ago the incidence of goiter in the population was 79 per cent. Ten years ago it became a law that all cooking and table salt had to have iodine supplied with it. As a result of this automatic use of iodine in the province, at the end of ten years the incidence of goiter had dropped from 79 per cent to 9 per cent. As indicating the developmental influence of thyroid activity in relation to this high percentage of goiter, it is of interest to state also that the average height of recruits in this period increased one and a half inches; that spina bifida, the failure of the spinal canal to close, diminished in incidence; and that hare lip and cleft palate, developmental and closure defects, also decreased in incidence.

The development of heparin, first described by Howell at Johns Hopkins, and first refined for clinical use by Best and his coworkers in the Connaught Laboratory in Toronto, is evidence of the rapidity of progress in medical development. By means of heparin it is possible to prevent the blood from clotting. It can be arranged

that clotting will not occur over any desired period of time. This can be done by controlling the amount of heparin administered.

Other advances are: The recent demonstrations by Best of the exhaustion theory in relation to the islands of Langerhans in diabetes and the very definite implication of the possibility of preventing diabetes; the experimental production by Goldblatt of hypertension in animals, giving us an opportunity for more complete and adequate study of this disease which causes 23 per cent of all deaths in this country; the discovery of the active principle of the adrenal gland, the loss of which in Addison's disease used to result in certain fatality. It is now possible to implant beneath the skin of patients desoxycorticosterone acetate, the synthetic substitute for adrenal secretion, so that people can now get along without medication for a year, have further implantations each year, and go on living toward a normal lifespan. Of similar value is the substitution treatment for the blood-forming element in pernicious anemia. These are a few of the outstanding examples of how rapidly the progress of medicine goes on.

With the above statements in mind, it is obvious how broad is the author's task and how necessary it is for students that such a subject be kept so adequately up to date as it is in this volume.

This book is written in such a clear and understandable form that not only will it be of value to students and nurses but it can also be read by any lay people with every prospect that they will receive a sound and proper conception of states about which their ideas are often hazy or obtained from popular and undependable sources.

Frank Howard Lahey
President-elect, American Medical Association.

The Lahey Clinic,
Boston, Massachusetts.

TABLE OF CONTENTS

PART 1

INTRODUCTION

Chapter 1

THE HEALTH SITUATION IN THE UNITED STATES

"The American people are the healthiest in the world, and the present generation is the healthiest in the nation's history." This definite and important statement from Surgeon-General Thomas Parran, M.D. of the United States Public Health Service appeared in the public press in January 1940.

Behind this statement are volumes of vital statistics indicating that the average length of life in the United States in 1939 was nearly 64 years.

Thinking of the Psalmist's three score years and ten as the days of man's years, it would seem that 64 years is not a high enough average, especially for a country as enlightened as this. Could we not extend the average length of life a few years more?

Doctor Parran suggests that we can. Following his statement quoted above, he went on to say that "further great advances in health might be made if all that science now knows about preventing and curing disease were to be put into effect."

This statement, too, is based upon statistical evidence that gains have not been made in preventing some of the diseases for which known preventive methods are available. For example, smallpox is increasing, although vaccination will prevent it.

It is beyond question a fact that the average length of life can be further increased. The question is, how much? Can it be indefinitely increased? Or is there a natural limit, beyond which no efforts of science could possibly extend life farther?

THE LIFE SPAN

The span of life is the length of life an organism can attain if all goes well. For each variety of living creature there appears to be such a natural life span. The dog, for example, is commonly supposed to have a life span about one-seventh of man's. Living things seem to be "wound up" to run just about so long, like the eight-

day clock which is wound up to run eight days and will do so unless something happens to it.

As for the life span of human creatures, we are told in the Bible that after man began to multiply on earth, God said "Yet his days shall be an hundred and twenty years." A little later we are told that "there were giants in those days"—giants in size and giants in longevity (length of life). Examples are Adam, who lived 930 years; Seth, 912 years; and Methuselah, 969 years.

Can it be that our average length of life falls so far short of what it should be, and that we must nearly double it to reach the natural life span? There are those who think that may be the case, although on the whole present findings do not suggest such possibilities.

Statistical Evidence.

Professor Irving Fisher, of Yale, on the basis of statistical computations has made the suggestion that we should not consider

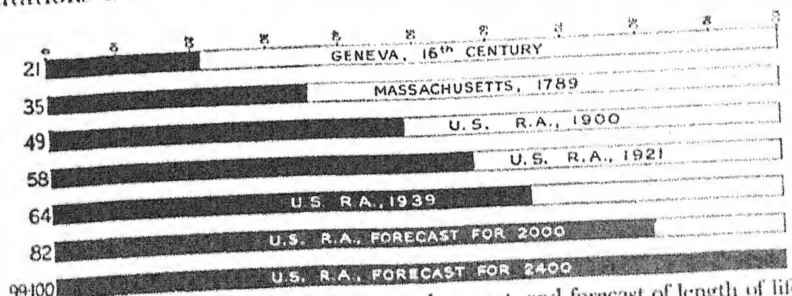


FIG. 1.—Average length of life in past and present, and forecast of length of life in the United States if the present rate of increase continues. (R.A., Registration Area, which now includes all states.)

length of life fixed, but should consider it in terms of "chance of survivorship, which diminishes indefinitely, but with no known or knowable limit."

"Chance of survivorship" certainly diminishes very markedly beyond the century mark. In fact, in modern times it is comparatively uncommon to live to be 90. In 1930, there were in this country only 40,544 women 90 years old or over, and still fewer men—only 26,117. For statistical purposes, insurance companies pay off a regular life insurance policy at the age of 96, just as if the person had really reached the end of life.

It is distinctly unusual to reach the age of 100. At any given time in this country insurance companies state that there will be possibly 5,000 at or beyond that age. But they cannot give one authenticated case of life beyond 106 years. Dr. Louis I. Dublin, a

leading authority on vital statistics, considers that the upper limit of life hovers around the century mark. His forecast of the ultimate age to be attained, possibly by 2400 A.D., is set at 99–100 years. This is shown in the lowest column in Fig. 1.

Biological Evidence.

It is thought that the rate at which development takes place, from infancy to adult life, may furnish a clue to the time an organism should live. In general, animals live five times as long as it takes for the skeleton to attain full growth. Man's skeleton attains full growth at about 21 years of age. Hence, theoretically man's span of life would be 105 years. It is to be noted that this figure coincides with the oldest age authenticated by insurance companies.

However, in experimental work with lower animals, occasionally results have been attained that arouse question whether a life span of a given length is natural for a given species.

For example, in 1938 it was announced by McCay of Cornell University that he and his associates had been able to cause rats to exceed the normal life span by feeding them a low-calory diet. Rats whose normal life span would be 600 days lived in some cases 1,000 days. And not only that, they remained young in appearance, whereas the normally fed rats showed the usual signs of old age. McCay says, "The life span is flexible, and the extent to which it can be increased is an unknown value."

Ingle, of Brown University, found the same to be true in two species of small water animals; short rations added an average of twelve per cent to the normal life span.

Sherman, of Columbia University and the Carnegie Institution of Washington, found that a diet containing more than the minimum of calcium, protein and vitamins A and G caused rats to live beyond their usual life span, with a particular extension in the period classed as "the prime of life."

Philip White of the Rockefeller Institution for Medical Research, reported in 1939 that he had been able to keep plant tissue young indefinitely, by his method of cultivating it with adequate nutrition plus plant hormones that have been found essential for growth. Had he been able to keep all that he raised, he calculated that the original piece of tissue would have increased to ten quintillion times its original size (10 to the 19th power), without ever coming to physical maturity.

These and many other experiments suggest that there may truly be no natural limit to life.

Genetic Evidence.

It is thought that not all individuals are alike in having the same natural life span. Casual observation suggests that longevity appears to "run in families." In some families it seems natural to live to a "ripe old age," and in others, impossible. Statistics from the science of genetics support the theory that heredity influences length of life as among individuals.

Years ago Alexander Graham Bell found that children of parents who lived to be 80 lived longer than those whose parents died before 60. In 1927 Raymond Pearl, as a result of experiments with fruit flies (drosophila melanogaster), announced the importance of heredity in determining their length of life. In 1930, Dublin, from a statistical angle, reported on families studied from 1900–1928, and stated that there were fewer deaths during that period among those whose parents died or were living after the age of 50 than among those whose parents died before 50. In 1931 Raymond Pearl gave added evidence that expectation of life in sons of fathers who live long is greater than in sons of fathers who die early. Conversely, those who themselves live long will more often be those whose parents lived long. Many others, among them Mazyck Ravenel and Karl Pearson, have contributed to our belief that heredity is a factor in longevity.

It should of course be noted that the death of the parents at an early age, or indeed of all the ancestors, proves nothing against the family's inheritance of longevity unless it is known that they apparently did live out their life span and did not die of accidental disease or injury before that time.

The Causes of Senility.

Whatever the natural life span, the possibilities of lengthening life depend upon an understanding of the causes that lead to old age or senility. It might well be that they are none of them preventable. On the other hand, it might be possible that individual efforts in the right direction could enable many individuals to stave off senility.

First, it may be noted that the biological state of senility is one in which the organism becomes old, and that this is not a matter of chronological age. In fact, senility may begin in the forties, or even before. Usually, after the peak of physical vigor has been reached, this level is maintained for some time before decline begins.

Senility is characterized by numerous degenerative changes in many of the organs. Probably all the cells of the body grow old

together in the normal aging process; but in premature senility one part may age more rapidly than another.

For many years there have been speculation and investigation regarding the causes that begin the process of aging. Among the early theories was that of Brown-Séquard who attributed aging to "hardening of the arteries." Virchow's phrase "A man is as old as his arteries" was popularized by him. Then came Metchnikoff, who held to the same theory, but enlarged it by maintaining that putrefaction in the bowel was what caused the arteries to harden. He stated that man should live to be 140 years old "and go to pieces finally like Oliver Wendell Holmes' one hoss shay," provided the large intestine could be kept free of putrefying bacteria.

Later, interest turned toward the endocrine glands. First it was thought that degeneration of the thyroid was the first step in senility; then, of the sex glands; and finally, of all the endocrine glands. Work along this line is continuing, and many interesting results have been published.

More recently, attention has been centered upon cellular nutrition throughout the body as determined by the kind of food eaten, with special reference to vitamins, and upon the character of the blood serum, with special reference to minerals.

Also, investigations have been made regarding the rate of living as a factor in length of life. From laboratory work, it appears that a slower speed of living tends toward longer duration of life. This would bear out the observation that humans who live to an advanced age have usually been of a placid temperament, and have had less "drive" in their lives. It is in this respect only that there seems to be any resemblance, other than heredity, among those in whom senility is long delayed.

Raymond Pearl has reported on a number of men first examined at the time when their average age was 40. In later years, after a considerable number of them had died, he found that those who lived to the oldest ages had when examined had a slower pulse, lower blood pressure, lighter weight, and slimmer build, and that they seemed to have expended less energy as they went through their lives.

It appears that "wearing out" may be quite literally wearing out.

AVERAGE LENGTH OF LIFE

Whatever the theoretical life span may be it is evident that most people do not reach it, but that, as time goes on, a larger proportion

of people in this country and all civilized countries do approach it.

The present longer length of life is due to the prevention of premature deaths—that is, of deaths that come earlier than they should, because of causes that need not have occurred.

The increase has been particularly marked in the past hundred years. It has been estimated that at the beginning of the Christian

Age	*Expectation of life, years*		
	Total persons	*White males*	*White females*
0	61.48	60.75	65.08
1	63.70	63.07	66.85
2	63.17	62.51	66.27
3	62.40	61.74	65.48
4	61.56	60.90	64.62
5	60.68	60.02	63.74
10	56.08	55.45	59.09
15	51.42	50.82	54.37
20	46.95	46.33	49.77
25	42.62	41.93	45.29
30	38.34	37.56	40.85
35	34.10	33.26	36.45
40	29.99	29.09	32.12
45	26.00	25.07	27.87
50	22.18	21.28	23.77
55	18.58	17.74	19.85
60	15.17	14.46	16.14
65	12.10	11.53	12.78
70	9.44	8.99	9.85
75	7.12	6.79	7.32
80	5.28	5.08	5.32
85	3.75	3.63	3.72
90	2.62	2.49	2.63

FIG. 2.—Expectation of life at specified ages for total persons (white and colored) and for white persons by sex, United States, 1937. (Courtesy of Dr. Louis I. Dublin, and the Metropolitan Life Insurance Company.)

era the average length of life could scarcely have been more than two or three years, and five hundred years ago, not more than eight years.

No adequate vital statistics were collected anywhere until modern times, but those that are available in this country appear to indicate that average length of life has nearly doubled since we became a nation. (See Fig. 1.)

In the words of Dr. Haven Emerson, professor of public health practice, Columbia University, "We are now possessors of better general health . . . and have an average expectancy of life greater than that of any population group in the history of man, comparable in size, variety of races, and distribution in age, occupation and economic and climatic conditions."

Within the United States, for some time certain states have shown a higher average length of life than others. Among the highest are some of the mid-western states including the Dakotas, Iowa, Kansas, and Nebraska.

It will have been noted in the quotation from Emerson that he used the term *average expectancy of life*. That term means the same as average length of life, but both terms require explanation.

The term average length of life suggests that it means the average age at which deaths occur. It does not mean that. The average length of life for any given year means the average age to be reached by a child born that year, i.e. his expectation of life or his *life expectancy*.

The figure for *life expectancy* is derived from *life tables*. These are elaborate statistical compilations of data, gathered over a number of years, regarding number of deaths and ages at death. Such tables are compiled by the Bureau of Census annually. They show how long any person at any given age in a given year may be expected to live after that time.

For example, the life table, Fig. 2, shows that a white male 20 years old in 1937 would be expected to live 46.33 years longer. The "46.33 years longer" is his expectation of life, or his *mean after-lifetime*. The two figures added together give the age he may be expected to reach.

Age +	Mean after-lifetime	= Lifetime
20 +	46.33	= 66.33

Obviously, in the case of an infant just born, who has lived 0 years, the mean after-lifetime is the whole life.

Age +	Expectation of life	= Lifetime
0 +	61.48	= 61.48

Therefore, expectation of life at birth in a given year is the *average length of life* for that year. This is what is meant whenever the term average length of life is used—the time that a person born that year will probably live.

Life tables prepared for special groups of people (i.e. for one state, or for one class according to occupation, etc.) may show considerable variation from the figures for the nation as a whole.

It will be seen, in Fig. 3, that there has been a great increase in expectation of life at birth. The child born now has a much better chance of living to reach old age. But the person now 50 has scarcely any greater life expectancy than persons of 50 had in 1876, or indeed at any time in history, if estimates of the remote past are correct. If males alone are considered, life expectancy at 50 is actually less than in former times.

Age	*1853*	*1933*
At birth	39.4	62.3
At 25 years	62.0	68.6
At 50 years	72.5	72.7

FIG. 3.—Expectation of life for white persons in U. S.

The rate of increase in life expectancy has not been uniform throughout our statistical history. It has proceeded much more rapidly since 1893 than it did before then. In the seventeen years from 1876 to 1893, length of life for males increased an average of about half a month a year. In the 46 years from 1893 to 1939 the increase has been at the rate of about five months every year, or nearly twelve times as fast as in the time immediately preceding—and what is more, the rate is still accelerating. The year 1893 appears to mark a break with the past.

For practical purposes, the increased length of life must be interpreted in terms of specific diseases. We must know which of them have yielded to the onslaught of science, and which are still standing firm.

MORTALITY AND SURVIVAL

In each city and town, an official, usually the Registrar of Births and Deaths, keeps accurate records of every death in his jurisdiction, from certificates filed by physicians. On the certificates are included the age, sex, and cause of death, the cause being stated in conformity with an international list of names of diseases.

By means of these records, each city or town computes its death rate, by comparing the number of deaths with the population. The *crude death rate* is the number of deaths per thousand total population.

$$\left(\frac{\text{No. deaths in total population} \times 1{,}000}{\text{Total population}} = \text{Crude death rate}\right)$$

When the term death rate is used it is understood to mean the crude death rate unless some qualifying term is used.

Specific death rates may be computed for each age, sex, or disease, or for any other factor given on death certificates, or for any class of people in the population (e.g. married or single, white or colored, professional or clerical occupation, etc.). To compute a specific rate,

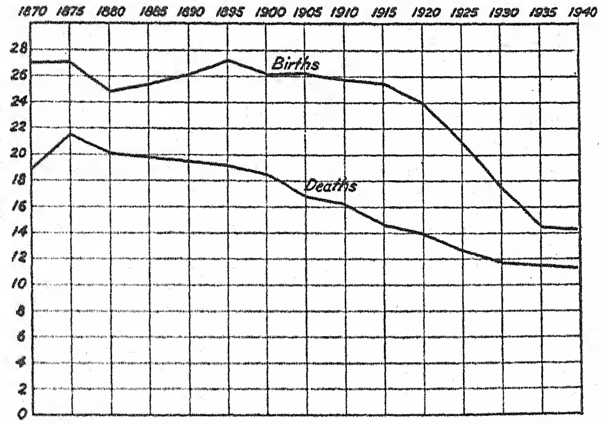


FIG. 4.—Decline in birth rate and death rate 1870–1939, in Massachusetts.

another factor is introduced in either numerator or denominator or both, and this factor is stated in the answer. For example,

$$\frac{\text{No. deaths under 1 year} \times 1{,}000}{\text{Total population}} = \begin{array}{l}\text{Deaths under 1 yr.}\\ \text{per 1,000 population.}\end{array}$$

The death rates for specific diseases are always computed and stated per 100,000, in order to avoid decimals.

Local mortality statistics are sent to State and Federal offices, and from these our state and national figures are obtained.

The crude death rate for the country at large in 1938 was 10.6. Twenty-five years ago it was 14.1. The number of lives saved year by year in the past twenty-five years, owing to decreasing death rates, totals nearly ten million.

Whereas the general mortality rate portrays the mass results of what has been accomplished and gives a group picture of the nation as a whole as affected by all factors combined, it is from the specific mortality rates that we obtain our best views of the situation. These give "close-ups" of the conditions in respect to each of the diseases as they appear in different ages, localities, etc. Upon these specific figures the professions of medicine and of public health judge of

what has already been accomplished and of what remains to be accomplished.

The Ten Leading Causes of Death.

In the country at large ten causes are responsible for three-fourths of all deaths. The rates for 1938 are shown in Fig. 5. The tenth, diabetes, caused 33,000 deaths, and the first, heart disease, more than a third of a million.

Among the deaths in 1938, 72% were from chronic diseases; 12% from acute diseases, largely infections; 9% from accidents; and 5% from the diseases peculiar to infancy.

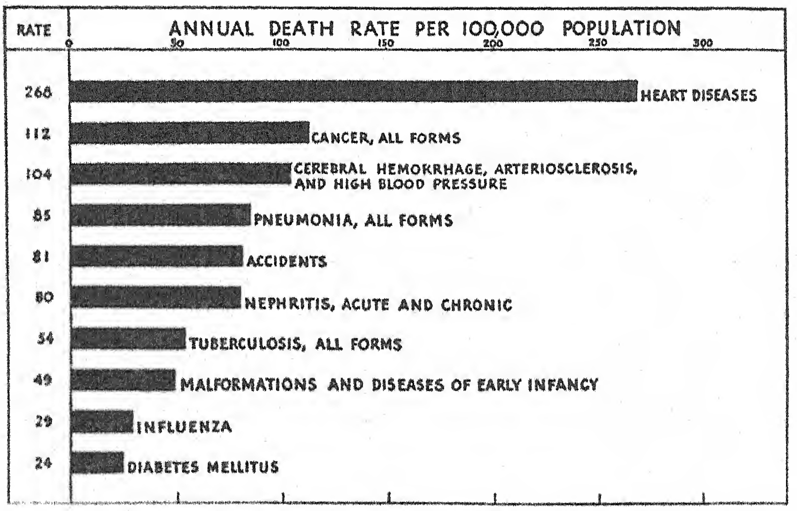


FIG. 5.—Principle causes of death in the United States 1937. (Courtesy of Assistant Surgeon General Mountin, U.S.P.H.S., and American Journal of Public Health.)

The question naturally arises, have the same diseases always been the cause of the greatest number of deaths? The figures for the state of Massachusetts, which was the first state to have a registration system, will help to answer that question. Tables that are comparable to those of the present are available as far back as the years 1856–60. It is probable that the figures are fairly representative of the country as a whole. They are shown in Fig. 6, their former rank contrasted with the rank in 1938.

Two diseases that were important in former times are less so now. Tuberculosis is only one-ninth as important as in 1856–60, and diseases of infancy less than half as important, and yet both are

still in the first ten. On the other hand, heart disease has become six times as important.

Excluding accidents, the ratio between chronic and acute disease is 3:1—just the reverse of conditions 80 years ago. This ratio prevails the country over.

Decline in Infant Mortality.

For different ages, specific mortality rates vary greatly. Fig. 7 shows that the highest death rate is from birth to one year of age. There is a steady decline until 10 years of age, and thereafter a steady rise. After one year of age, the death rate is not equalled again until nearly seventy years of age. These facts point clearly to a major objective in health work.

	Rank (Mass.) 1856–65	*Rank (U.S.)* 1938
Tuberculosis	1	7
Diarrhea and enteritis	2	
Diseases of Infancy	3	8
Scarlet fever	4	
Pneumonia	5	4
Old age	6	
Typhus	7	
Accidents	8	5
Heart disease	9	1
Diphtheria and croup	10	

FIG. 6.—Leading causes of death, according to rank, in Massachusetts 1856–60, and in that state and the United States in 1938. Note that five diseases are no longer among the first ten, and that the other five have changed their rank.

However, the infant death rate is declining. In Massachusetts, a state having records for the past 90 years, and in most of the states, the steady decline began shortly after 1900. (See Fig. 8.)

In 1900, the rate in Massachusetts was nearly 160—that is, 160 babies of every thousand born alive did not survive the first year. In eight cities in the United States in that year, the rate was between 300 and 419; in other words, of every six babies born in 1900, one or two died before the first birthday. Today, in the country as a whole the infant death rate is 48, which means that more than 95% of babies born alive live at least a year. Other data show that 90% live to age 24.

Decline in Mortality from Communicable Disease.

In addition to the decline in the infant death rate there has also been a marked lowering in the death rate from the communicable diseases. Many of those that formerly loomed large in the mortality

In some states one disease on this list is crowded out from the first ten, because of the greater prevalence of another disease. For example, malaria ranks in the ten leading causes of death in two southern states; syphilis, in two states; and appendicitis, in four states.

	Pneumonia	*Tuberculosis*	*Whooping cough*	*Scarlet fever*	*Measles*	*Diphtheria*	*Typhoid fever*	*Smallpox*
1856–1865	107.4	446.4	23.8	101.3	17.1	86.1	92.5	11.0
1866–1875	132.2	401.2	20.7	76.6	15.1	58.4	80.8	17.3
1876–1885	150.1	378.3	15.1	33.8	9.6	127.2	47.4	1.3
1886–1895	180.7	326.8	12.8	20.6	8.7	73.7	36.9	0.3
1896–1905	174.7	242.9	10.3	9.9	7.3	38.4	21.0	1.6
1906–1915	174.1	170.5	8.2	6.9	6.4	19.4	10.6	0.1
1916–1925	164.8	113.7	9.3	3.7	7.8	15.2	2.9	0.06
1926–1935	99.1	62.8	3.7	2.4	3.0	3.8	0.8	0.002
1936	96.3	43.1	1.2	1.0	0.8	0.6	0.2	0.000
Per cent decline	10.3%	90.3%	94.9%	99.0%	95.3%	99.3%	99.8%	100.0%

FIG. 9.—Eight communicable diseases in Massachusetts. Average death rates per 100,000 with percentage decline 1856–1936. (Courtesy of Dr. Henry D. Chadwick and the New England Journal of Medicine.)

Reasons for the Decline in Mortality.

With respect to infant mortality and the communicable diseases, *available scientific knowledge* was obviously an important factor. The year 1893, when the decline in our general death rate began to be rapid, was the year when some of the new discoveries in bacteriology (e.g. antitoxin for diphtheria) began to be widely used. Also, in that year, the first large use was made of the new bacteriological standards for pure milk.

However, another factor was of importance also—the degree of *public interest* in these matters. Because of early spectacular results, the public was stirred to appropriate money and to stand behind public efforts to check communicable diseases and the death of infants. Because of the popular discussion of these subjects, large numbers of individuals applied the principles of medical science in their own and their family affairs.

Other declines in the death rate have been for similar reasons. Wherever the death rate has declined it has been because scientific methods were available and public cooperation was strong. Any further declines will be for the same reasons.

MORBIDITY AND HEALTH

Important as are the death rates as a measure of our national health, the truest measure is the proportion of sickness and health. Even though sickness never led to death, it would still be of itself a matter of great significance. As a matter of fact much illness is not fatal, yet it causes people to be uncomfortable and disabled, and prevents them from enjoying life to the full. Also, much illness is preventable. Therefore it is highly important that we know as much as possible about the sicknesses that prevail, and among which groups of people, according to age, sex, etc.

The statistics regarding sickness are called morbidity statistics (*morbus*, sickness). They are stated per 100,000, unless otherwise specified.

$$\frac{\text{No. cases of a given disease} \times 100{,}000}{\text{Population}} = \begin{array}{c}\text{Morbidity rate} \\ \text{(for that disease)}\end{array}$$

The prevalence of a given disease may also be stated in proportion or per cent. The term incidence (falling) is used to indicate the number of people who fall ill. For example, it might be stated that in a given school the incidence of measles was 1:5 or 20%.

Reportable Diseases.

The only morbidity statistics that are regularly collected officially are those for the communicable diseases. Each city and town has a list of reportable diseases, and physicians or others in charge of a case are required to report it to the board of health.

Locally collected statistics are sent to State and Federal offices, whence come the data regarding the prevalence of communicable diseases.

Smallpox was the first disease to be made generally reportable; the veneral diseases, the most recent. Local lists now include practically all of the specific infectious diseases, but do not include that most communicable and certainly most prevalent disease, the common cold.

Diseases Not Officially Reportable.

Regarding the diseases not reportable to boards of health, much information is available from various sources. In many groups accurate sickness records are regularly kept, every illness being reportable to the physicians in charge. Although kept for their own purposes, many of these records afford statistics that are made

available to the public. Among the sources of much data are: the Army, the Navy, the Merchant Marine, insurance companies, public and private schools and colleges, fraternal orders and mutual benefit societies, industrial plants, department stores, banks, etc., and of course, the hospitals, dispensaries, clinics, sanatoriums, and private physicians.

Sickness Surveys and Censuses.

From time to time attempts have been made to obtain a large mass of data on sickness among unassorted individuals in the general population by means of surveys. Four thousand sickness surveys have been made in this country since 1900.

The one-day census has frequently been used, in New York and other large cities. Its aim is to obtain a "snap-shot" of the sickness situation on one average day, on the supposition that it will be a good likeness of the situation on any other day. Of course the results depend for their accuracy upon choosing an average day, sampling the population in a representative fashion, and conducting the interviews appropriately, so as to reveal what is present, but only that.

The National Health Survey carried out in 1935–36 by the United States Public Health Service, followed the same principles, but on a much larger scale. It covered 83 cities and 23 rural areas in 19 states. In all, 800,000 families, representing 2,800,000 individuals, were interviewed. Interviewers were at work for an entire season (the winter months from November to March).

Rates of Sickness.

The data from all the aforementioned sources gives very much the same information—that diseases and defects are very common.

The National Health Survey revealed, first, that on the day interviewed a high percentage of people were disabled. The age group from 15–24 is definitely the healthiest—only 1 in 40 of this group being disabled on the day interviewed. For those under 15 and from 24 to 64, the rate averaged nearly twice as high. By *disabled* is meant kept from work, school, or other usual activity.

From the rate among those interviewed, it is estimated that 6 million people in the United States are thus disabled on each winter day. Of these, one and a half million are disabled by acute (brief) infections of the respiratory tract (colds, influenza, grippe, pneumonia, tonsilitis, etc.). Two and a half million are disabled by chronic (lasting) diseases such as those listed in Fig. 11. Half a million are disabled by injuries due to accidents; a quarter million

by the acute specific diseases often called "children's diseases"; and another quarter million by diseases of the stomach and liver, and appendicitis. The rest (one million) were disabled by an assortment of acute diseases.

Information was also obtained by the National Health Survey regarding the number of illnesses disabling for a week or more in the previous 12 months. The causes, frequency and duration were as follows.

Diagnosis	*Frequency per 100 persons*	*Days of disability per case*
All causes	17.2	57
Infectious and parasitic	2.9	24
Respiratory (chiefly acute)	4.7	19
Digestive (chiefly acute)	0.9	49
Puerperal state	1.5	34
Accidents	1.6	46
Chronic diseases	4.6	138
All other causes	1.0	78

FIG. 10.—Illnesses disabling for a week or more.

Chronic Disease.

Regarding chronic ill-health, a condition was not listed as such unless the informant considered it handicapping. A list of the chronic handicapping diseases that were found most often is shown in Fig. 11. On the basis of the survey, it was estimated that each of these was present in the general population to the extent of 200,000 or more, according to the figures shown. The total number of cases of chronic disease occurring annually in the United States is estimated at 36,750,000.* But since one person may have more than one disease, the total number of persons annually having chronic disease is less than that figure. Including both chronic disease and permanent impairment, the number is estimated to be 23,000,000,

* *Syphilis, hookworm and malaria were not included in the inquiries, because it was believed that accurate information would not be obtained in house to house canvass. From other sources, it appears that syphilis would be 2nd on the list, with* 6,000,000 *cases. In regard to syphilis it should also be noted that cases of syphilis of the nervous system make up a considerable proportion of the diseases listed under nervous and mental illnesses. Malaria and hookworm also would be high in the list, especially in rural districts.*

Ailments described in vague terms were not listed, although they were reported often enough to make the estimated number for the United States to be [illegible]000,000.

or about one-sixth of our population. Since even chronic diseases may recover, or may cease to be handicapping, the number of those who were disabled for the entire 12 months prior to inquiry becomes

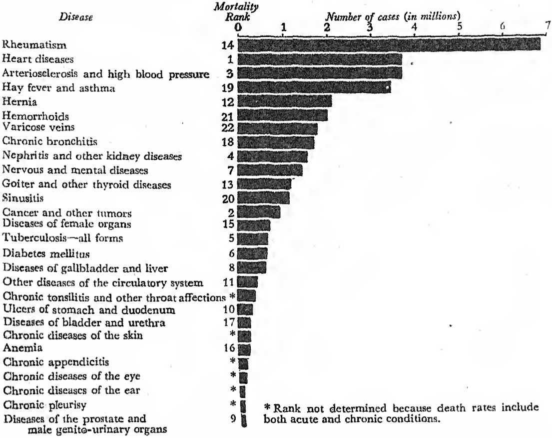


FIG. 11.—Estimated prevalence of specified chronic diseases in the United States (1937), and mortality rank of each within this group.

much smaller. Chronic disability in the United States is estimated at no more than one and a half million as follows:

Chronic invalids	991,300
Cripples (skeletal, eyes, ears)	350,000
Indefinite causes	120,000
	1,461,300

Fatality Rates.

The fatility rate of a given disease is the percentage of cases that terminate fatally. In some diseases the fatality rate is zero. For example, no one ever dies of either a cold or of chicken pox unless complications arise.

Among the acute diseases reported most often to cause disability of a week or more, only two groups are also large causes of death—the respiratory diseases, including pneumonia; and the digestive

diseases, including appendicitis. The specific infectious diseases, such as whooping cough and scarlet fever, together do not more than equal the fatality of appendicitis alone.

To show the fatality of the chronic diseases, small figures have been inserted beside each block in Fig. 11 to show the rank of that disease as the cause of death among the diseases in that series in 1937. It will be noted that some, especially those of the heart, blood vessels and kidneys, have high rank from both points of view. In the whole series of chronic diseases, 85% of deaths occurred in persons over 45.

Decrease of Sickness.

Sickness in general is decreasing. The incidence of many of the communicable diseases is far less than formerly. As for the other diseases, some of them are reported more often than formerly, both as causes of sickness and of death. This is true of the chronic diseases of the heart, arteries and kidneys in particular. However, part of the explanation may be that more people are now living to the age when these diseases appear. In general, the evidence does indeed confirm the Surgeon-General's statement that "the present generation is the healthiest in the nation's history."

The Rate of Health.

The usual method of arriving at the number of well people in a group is to subtract the number of the sick. By this process of exclusion, the vast proportion of our population falls into the class of the well.

Using the estimates of the National Health Survey, if 1½ million of our population are invalids, 128½ million are not; if 23 million have chronic disease or permanent impairment, 107 million have not; if 6 million are disabled on any winter day, 124 million are not.

Whereas it is a source of great satisfaction to think of the large number of people who do not enter into the sickness records in any way, it is open to question whether they should all be called well merely because they are not sick.

Biologically, health is the positive state and disease the negative one. Actually, what we should do to arrive at the ratio between the well and the ill is to count the well people in a group and subtract them from the total to arrive at the number of the sick.

For obvious reasons, we must usually compute it the other way around, but we should bear in mind that being *statistically* well is not the same as being *biologically* well. A statistically well person

is one who is not sick enough to count in sickness records. A biologically well person is not sick at all. In fact his state is not to be described by negative terms but by positive ones.

Health may be defined in positive terms as a state in which the body is ready to act, in all its functions fully and freely and comfortably, in response to reasonable demands; and having acted, is able to restore itself promptly to its resting state, and to renew itself for further action. A state of health is accompanied by a pervasive sense of well-being known as euphoria. Anyone who has experienced it knows that it is quite different from mere absence of discomfort. It may even be present during normal "healthy" fatigue.

According to this standard, certainly not all of those who are able to be "up and around" and can be at work, and have no chronic illness nor gross bodily defects, can be classed as well.

Ratio of Health and Sickness.

It appears that in large groups of unselected individuals there will be some, perhaps 10%, who are virtually well—persons who

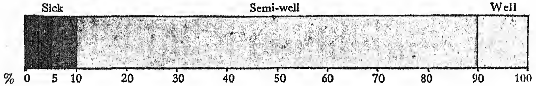


Fig. 12.

can count upon their health, barring accidental happenings; who will be ready for anything they may wish to do and able to do it with ease; who, in a word, "enjoy good health." In them there will be no demonstrable evidence that this happy state of affairs will not continue—again, barring accidents of disease or injury.

At the opposite extreme, will be another group, perhaps 10%, who are sick—who have diseases or defects that either give discomfort or are a menace to future health, or that limit activity. Of these perhaps half will be actually disabled, or in a condition in which they should not work, on any given day (indicated by darkest shading in Fig. 12.)

Between these two extremes will be those who are neither sick nor well, but semi-well. Their state may be called sub-maximum health.—less than the best.

These proportions were found to prevail in over 10,000 individuals in college and in industry.

Sub-maximum Health.

The main evidence of sub-maximum health is often lack of abounding vitality. The individual does not feel as full of energy as

he would like to, becomes fatigued too readily, or does not awake refreshed in the morning. Or he does not look as well as he might. Or he is bothered with minor ailments such as constipation, or aches and pains here and there. Or he is subject to frequent colds, or to attacks of indigestion, or to headaches, and the like. Upon medical examination, there may be practically nothing to account for his being below par. But upon discussing his habits of living, there may be clear evidence that he is not providing favorable conditions for the body mechanism to maintain itself in good running order.

Sub-maximum health appears sometimes to be due to constitutional inferiority. Not everyone is born to be well: not everyone has an equally good inheritance. Also, not everyone has the same care in infancy and childhood. Conditions early in life may undermine the organism's stamina and make real health impossible.

With these exceptions, large numbers of people could move from the group of the somewhat unfit to the group of the wholly fit. This has been clinically proved time and again in the experience of all physicians.

Increase of Fitness.

It has been shown that the general death rate and the death rate for many diseases is decreasing; that sickness rates for many diseases are decreasing, and the total amount of sickness, while still high, is decreasing; and that length of life is proportionately increasing. Is it also true that real fitness is increasing?

That question cannot be answered in statistical terms for the general population. The answer would have to come from physicians who see many so-called well people (as in colleges) and gauge degrees of health. Many such physicians believe that the general level of health has risen, quite apart from the reduction of actual disease.

It appears that as a nation we are actually adding to fitness as well as subtracting from sickness, but that there is still a long way to go before those of the semi-well who are entitled to rise to the level of the well actually do so. In other words, we have much to do before the statistically well become the biologically well.

PART 2

THE BODY

Chapter 2

THE GENERAL PLAN OF THE BODY

Casual Observations.

To the casual observer, certain facts about the body are apparent. For example, it is obvious that it consists of a firm inner structure which one learns early in life to recognize as bones; that this framework is movable at certain places called joints; that between the skin and the bones is a varying amount of "flesh" recognizable as muscle and fat; that a pinkish membrane continuous with the skin begins at the lips and continues as far as can be seen; and that the openings of the body lead into internal regions whence come hints that activity is going on (e.g. lungs, stomach, bladder, etc.), and from which one might easily surmise the existence of functioning parts called organs.

Also, it is obvious that the body contains blood, occasionally shed through wounds; that it produces fluids (sweat, saliva, tears, etc.); that it has feelings (of touch, pain, heat, cold, etc.); and that it moves, both at will and "of its own accord" (as in winking).

Particularly notable is the fact that the body undergoes change within, and that some of these changes are constructive—as, for example, the remarkable phenomenon of growth from conception to adult life, and of renewal of energy through food and sleep.

Scientific Observations.

Intrigued though man was by casual observations such as those mentioned, and mystified though he was as to their meaning, he made little progress in understanding them until the sixteenth century. At that time systematic investigations of the body began, part by part, and function by function.

First, by slow, painstaking, orderly research, begun by Vesalius, the facts of gross anatomy (the structure of the body, as visible to the naked eye) were revealed. Then some of the important principles of physiology were discovered, with William Harvey as the great pioneer. Soon Malpighi with the microscope began uncovering the microscopic structure of the body.

On these foundations has grown, and is still growing, a vast volume of knowledge of how the human body is built and how it works.

A. GROSS STRUCTURE

Framework.

Architecturally, the body forms a torso or trunk, to which are attached two pairs of extremities, and from which rises the neck, topped by the cranium or head. The lengthwise support of the trunk is the spinal column, continuous through the neck to the head.

The bones of both the cranium and the trunk are so arranged as to enclose, or partly enclose, certain cavities which contain organs.

Dorsal Cavity.

The dorsal (back) cavity is formed by the bones of the skull and spine. The space within the skull is distinguished as the cranial cavity. It contains the brain and certain other structures. The space within the spine is called the spinal cavity. The spine consists of a number of separate bones called vertebrae, each with a vertical opening at the center. These bones, one above the other, form a continuous series of spaces, which house the spinal cord, continuous above with the brain. Nerves branch off from both brain and spinal cord, and pass out from the dorsal cavity through openings in the skull and spinal column. Also, blood vessels pass both into and out from these cavities.

Ventral Cavities.

The ventral (front) cavities are enclosed by the bones and muscles of the trunk. They are three in number, one above the other: thoracic; abdominal; and pelvic. Between the upper two is a partition (a sheet of muscle called the diaphragm). The lower two are continuous.

a. The thoracic cavity (or chest, or thorax) contains the heart and the lungs. Connected with the heart are large blood vessels (arteries and veins) to carry blood out from and in to the heart, to and from all parts of the body, and to and from the lungs. Leading into the lungs from the throat is the trachea ("windpipe") and its branches (bronchi) which carry air back and forth between the lungs and the exterior. Through the thorax also passes the esophagus (gullet) from the throat to the stomach.

b. The abdominal cavity (or abdomen, or belly) is enclosed chiefly by the muscles of the trunk. It contains the food tube, which begins at the mouth, and continues as the stomach and intestines.

Also, it contains several other large organs (viscera)—the liver, gall bladder, pancreas, spleen, and two kidneys.

c. The pelvic cavity (or pelvis) is partly enclosed by the hip bones. In it are the terminal portions of the intestines, the bladder, and the reproductive organs, except for those that, in the male, are suspended from it.

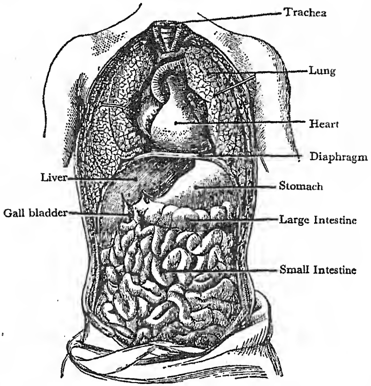


Fig. 13.—Some of the thoracic and abdominal organs. (After Le Pileur.)

Other Cavities.

The bones of the skull and the face enclose the two orbital cavities for the eyes; the two aural cavities for the organs of hearing; the buccal cavity, or the mouth; the nasal cavities and the eight sinuses. Passages from the eyes, ears, and sinuses lead into the nasal passages. At the back of the nasal cavities and of the mouth, and continuing downward a short distance, is the pharyngeal cavity, or throat, which gives access to both the air tract and the food tract.

External Openings.

The openings of the body communicating with the interior, are the nose; the mouth; the anus, from the intestines; the urethra, from the bladder (and in the male, also from the sex organs); and, in the female, the vagina, from the uterus or womb. Included in this list should also be the eyes and the ears, which are anatomically

constructed so as to give access to the interior, although they are physiologically the openings only for the reception of light and sound.

Tissues.

All the "fabrics" of which the body is made are called tissues, although some of the tissues do not correspond to the common use of that term. In form, a tissue may be a thin sheet-like structure, as the name suggests, or of any three-dimensional proportions and of any density.

There are five main varieties of tissue, as follows:

a. Epithelial Tissue.—The skin and a somewhat similar membrane that lines body cavities and covers organs are of epithelium. Another type of epithelial tissue (glandular) forms the substance of certain organs such as the kidneys, thyroid gland, etc.

b. Connective Tissue.—This tissue occurs in several different forms. *Bone* is osseous connective tissue; *fat*, adipose connective tissue; and *tendons*, *ligaments*, etc. are fibrous and elastic connective tissue. Throughout the body, bands, sheets, or fibers of connective tissue, chiefly of the fibrous type, are intermingled with other tissues to strengthen or support them.

c. Muscle Tissue.—There are three types of muscle tissue. One sort forms the skeletal muscles, which are attached to, and move, the skeleton. Another sort occurs as muscle fibers forming a considerable part of the wall of most of the hollow organs (e.g. bladder, stomach, etc.) and of tubes (e.g. intestines). Wherever such muscle fibers exist their contraction enables the organ to change its shape. A third sort of muscle tissue is that which composes the heart.

d. Nerve Tissue.—This highly conductive tissue forms the brain, the spinal cord, the nerves, and other nerve structures.

e. Blood.—Blood is usually classified as a fluid tissue. It is found within the heart and the blood vessels and in the organs where it is formed.

At any given point within the body, two sorts of tissue are always to be found—blood, and nerve tissue. Epithelial, connective and muscle tissues are also widely distributed. For example, a muscle consists mainly of muscle tissue, but it also contains fibrous, elastic and adipose connective tissue.

By weight (and in general, also by bulk) the body is one-half muscle tissue; one-third, connective tissue; one-tenth, epithelium; one-twentieth, blood; and one-fiftieth nerve tissue.

B. PROTOPLASMIC CELLS

Cellular Structure of Tissue.

If a very thin section of any part of the body is prepared so that it can be examined under the microscope, it will be found that tissues are not homogeneous, but that they consist of many small units. These units are called cells. They may be likened to the bricks that form a house.

In the different kinds of tissues, cells vary in shape and size. Most of them are less than $\frac{1}{1000}$ of an inch in diameter. Cells also vary in their proximity to each other. There is always a small amount of fluid between them, and in some tissues the cells are separated by a considerable amount of intercellular material, which may be likened to the mortar between the bricks. Such material is especially abundant in the connective tissues (e.g. bone consists of comparatively few cells widely spaced in the midst of much mineral substance, which gives bone its characteristic hardness). In blood, the cells are separated by a fluid (plasma) in which they float.

Tissues vary in their consistency partly according to the type of cells that compose them, and partly according to the amount and kind of intercellular material.

Living Units.

Although structurally cells are the ultimate microscopic subdivisions of tissue, their importance lies in the fact that functionally they are its living units. Each cell is alive; and it is because its cells are alive that the body as a whole is alive. In fact, every living thing, plant or animal, lives because the cells of which it is composed live.

It will be seen that likening cells to bricks in a house is more or less correct structurally, but that a better simile would be to liken cells to people living together in a city.

Cells are fundamentally alike in that they consist of small parcels of protoplasm, the chemical compound that is characteristic of living things and of nothing else.

Protoplasm.

Protoplasm is the only known form of matter in which life is manifested. If a definition of life is required, one may reverse the previous statement and say that, physiologically at least, life is the sum of the characteristics of protoplasm.

Protoplasm is unique in its chemical composition. It consists of water, proteins, lipoids (fat-like substances) and inorganic or

mineral salts. The elements contained in it are carbon, hydrogen, oxygen, nitrogen, sulphur, and usually many others (in the human body, at least fifteen in all). The five mentioned form protein, which distinguishes protoplasm. Protein is never absent from living substance, and never present in anything but the living or that derived from the living.

Although attempts have been made to manufacture protoplasm, no one has yet succeeded in putting its elements together in any combination that makes protoplasm. Apparently it is formed only in living cells, which are formed only from parent cells.

Instability of Protoplasm.

The main characteristic of the chemistry of protoplasm is its instability; it is in a constant stage of change. Every cell is a virtual whirlpool of chemical activity. Many of its changes are distinctive of protoplasm and of nothing else—that is, they are biochemical, the prefix *bio* meaning life, and the whole word meaning chemical reactions in living matter.

The susceptibility of protoplasm to change is sometimes described as *irritability*, by which is meant that it is capable of being stirred, or of reacting, or of responding, to matter and forces outside itself. That which excites it is called a stimulus. The stimuli that excite protoplasmic response, and lead to changes in protoplasm, are chemical, or physical (thermic, mechanical, electric, etc.), or a combination of the two, as in the nerve impulse.

The irritability of protoplasm is due to its biochemical make-up, which, as has already been stated, is not uniform in all cells, nor at all times in the same cell. Cells vary in the kind of stimuli to which they respond (e.g. certain cells in the ear respond to sound waves so as to give the sense of hearing, and certain cells in the eye respond to light). All cells respond to the nerve impulse or to chemicals circulating in the body, or to both, but the kind of response differs according to the nature of the cell (e.g. muscle cells contract and gland cells secrete).

All cells are more or less constantly reacting in one way or another to many kinds of stimuli from without the body and from within it, and, as a result, their protoplasm is constantly changing, chemically and physically.

Results of Change in Protoplasm.

The outstanding fact about protoplasm is that the changes that go on in it tend toward self-nutrition and adaptation to its environment. It is this characteristic of the living that distinguishes it

from the non-living and makes every cell a perpetual mystery to scientist and philosopher alike. But even though the ultimate secret of life is hidden in every cell, it is clear that the answer to the problem of maintenance of life must be sought through studying the life of the individual cell.

C. SINGLE-CELLED ORGANISMS

The Unicellular Organism.

Some cells are capable of individual existence by themselves, each constituting an *organism*, or living matter organized to live as a unit. These are called free-living cells, or one-celled, single-celled, or unicellular organisms. Other cells live only in organized groups, composing a multicellular organism. Almost all plants and animals that are visible to the naked eye are multicellular, but most of those visible only through the microscope (microorganisms) are unicellular (e.g. bacteria).

A cell continually carries on biochemical reactions between itself and its environment. The cell takes chemicals *from* its environment, and gives off chemicals *to* its environment; and meanwhile is constantly undergoing chemical change within. What every cell needs to take in is materials for its nutrition—that is, materials to provide for its growth for a time after it is first formed, and for its maintenance and its use of energy throughout life. What every cell needs to give off is the waste that is inevitably formed as a result of its activity, and that would be harmful if retained.

Between intake and outgo, there occurs a vast amount of change within the cell, making over what it has taken in, incorporating some of the material into its own substance, using some as the source of its energy, and preparing the rest for excretion.

Metabolism.

The sum of the internal chemical changes in a cell is known as its metabolism, which consists of two phases—anabolism and katabolism. The processes that result in the upbuilding of the cell and of its supply of energy are anabolic. Those that take place when the cell works, that wear the cell down and use its store of energy, are katabolic. The cycle of life is:

$$\text{Intake—}\underbrace{\text{Metabolism}}_{\text{Anabolism:Katabolism}}\text{—Outgo}$$

The two phases of metabolism go on simultaneously, and in the period of stationary growth should balance each other.

Use of Energy.

If vitality is maintained and energy generated by anabolic processes, then energy may be used. In the case of the single cell, the use of energy is limited in scope. In fact, it uses most of its energy merely to keep on living—that is, for self-preservation. Ultimately its energy is finally expended in dividing itself into two cells, which process results in the perpetuation of its kind.

Incidentally, while merely nourishing themselves in their preferred habitat and on their preferred food, unicellular organisms may rise to an important position in world economy. This is true of bacteria, for example. Because of what they take from and give

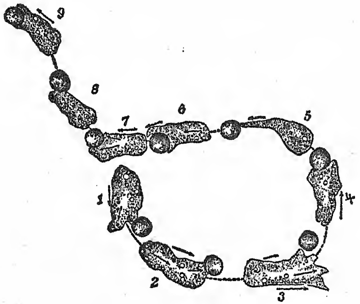


FIG. 14.—An amoeba in search of food, following an encysted euglena in an effort to engulf it. At 3 and 5 it nearly lost it and at 6 and 9 nearly engulfed it. (Atwood's "Biology.")

to their environment, they may profoundly affect living conditions for other organisms. Some bacteria that live outside the human body (e.g. some of the soil bacteria) affect conditions for the better; but those that are parasites on man usually create great havoc in his body because of the poisonous substances they produce while simply attending to their nutrition. That they must also fulfill their second function—that of reproduction—makes matters all the worse when they infect man.

Adaptation.

Two factors determine whether life goes on in the single cell. First, its survival depends upon a favorable environment providing enough of what is good for it and not too much of what is harm-

ful. Cells vary in their nutritional needs and also in respect to what harms them. To certain environmental conditions, however, no cell can adapt. Among the invariably lethal influences may be mentioned: severe mechanical injury that destroys its structure; extremes of temperature, certain electrical currents, and certain chemicals—all of which coagulate its protoplasm; and certain other chemicals that are protoplasmic poisons.

Second, the cell's survival depends upon its ability to utilize what is good for it and to overcome what is bad for it. Within limits, the continued existence of cells depends as much upon their vitality as upon their environment. Cells that have previously been adequately nourished and well supplied with energy are better able to adapt when crucial situations arise.

It will be seen that life is a process of adaptation, tending toward survival during the organism's lifespan. Conversely, death is failure of adaptation, which theoretically should not occur until the end of the normal span of life for the organism.

D. MULTICELLULAR ORGANISMS

The multicellular organism originates from one cell, usually formed by the union of two cells, one from each parent. The single cell, soon after it is formed, divides into two, and these into two others, until finally the organism has attained full growth.

Because all the cells in the multicellular organism originate from a single cell, it might be supposed that all of them would be alike; but such is not the case. Early in the process of multiplication of cells, a process of differentiation begins, whereby several varieties of cells are formed, each sort being somewhat different from the others in appearance, and, still more important, in function. This makes possible a division of labor, with one sort of cells doing this work, and another sort doing that.

As its cells specialize in their particular work, they become especially skilled in doing it, and thereby the adaptive power of the whole organism is increased, provided there is good team work among the cells. It will be obvious that the multicellular organism is a biological advance over the unicellular organism. For example, in an organism whose cells specialize in protective coverings (e.g. the crustacea, or shell-bearing creatures such as the lobster) the chances of the organism's survival are greatly increased.

It is to be understood that in the multicellular organism each cell lives a life which is, in principle, precisely the same as that of the free-living cell, but that its work of self-preservation includes

also the special work it has to do for the whole organism, and that it both needs help from other cells, and gives help to them. There is virtually complete interdependence of cells—and of the whole unit organism with each of its lesser units.

From this point, the discussion will deal exclusively with man, the most highly developed of all organisms.

E. THE HUMAN ORGANISM

Kinds of Cells.

The human body is composed of billions of cells, all derived from one cell (formed by the union of two cells, one from each parent). They are differentiated into five main groups, each with several subgroups. Each sort makes up a typical tissue, of which the five varieties have already been mentioned. Cells are named according to the tissues they form—epithelial, connective, muscle, nerve, and blood.

In addition, there are the sex cells, that do not form a tissue, but are contained in the sex glands. These cells are exclusively for the reproduction of the whole organism.

Intake and Outgo from Cells.

Most of the body cells are submerged by the bulk of cells around them, and do not have direct access to the outside environment from which to take their nourishment, or to which to give their waste. Nevertheless, the principle already stated, that all cells interact chemically with their environment still holds true. The difference is that there are several "middlemen" between body cells and the outside world.

Cells interact primarily with their immediate environment, a fluid called lymph, which, in small amounts, surrounds each cell. Some of the chemicals in lymph pass into cells, and some of the chemicals in cells pass into lymph. Both intake and outgo from cells is thus provided for.

The chemicals that cells take from lymph have entered lymph from the blood. As the blood flows slowly through the small blood vessels, some of the chemicals in it pass out into the lymph between cells. The blood, in turn, has derived these chemicals from three sources; (*a*) the digestive tract (food and water); (*b*) the lungs (oxygen); and (*c*) other cells (various substances they have given off). In the last analysis, everything that enters body cells comes from the outside world, although there may be much intervening time and space.

Conversely, chemicals that leave cells pass first into the lymph, then into the blood, and finally to other cells, which either use them or excrete them from the body. Just as the digestive tract and the lungs are the main routes for cell nutriment entering the body, so are the kidneys and the lungs the main routes for cell waste passing out of the body.

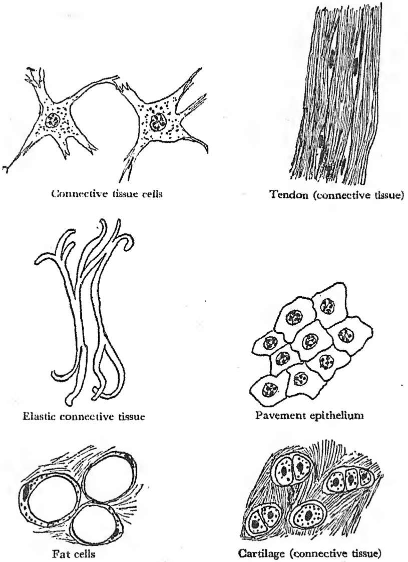


FIG. 15.—Various types of cells.

Selection of Chemicals by Cells.

One of the most remarkable facts known to science is that cells can respond to their needs by taking from the blood the chemicals that serve their purposes. In health they will always do so, provided the needed chemicals are at hand in an available form.

Formerly this rather mysterious power of cells was thought to be due to some strange "vital power" in the cells that did not

operate according to any knowable laws. Now it is becoming explainable by the laws of physical chemistry. Part of the story is the difference in osmotic pressure within the cell and outside it, some chemicals passing through and others not, according to the laws that govern the passage of fluids and gases through membranes. And at the bottom of it all is a condition of electronic stress within the chemical molecules, which makes them ready to make certain changes between themselves and their environment.

Metabolism in the Body.

All the cells in the body take in oxygen, food, and water for their own nutrition, to keep themselves alive and active and to

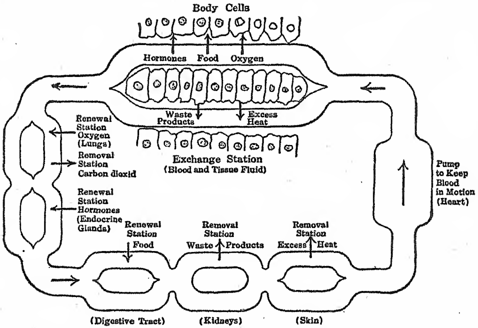


FIG. 16.—Diagram to illustrate the means whereby exchange takes place between cells and the blood. (Martin's "Human Body," Courtesy Henry Holt & Co.)

repair their daily "wear and tear." In so doing, they keep the body as a whole alive and active and in repair. Also, it should be added that there are two other essentials. From the outside they require also light and a correct temperature. These enter into the metabolic process as aids to the chemical processes of nutrition and energy production.

The sum total of all the chemical changes going on in all the cells of the body is known as the body's metabolism. As previously stated, metabolism consists of two phases; the upbuilding or constructive phase, known as anabolism; and the tearing down or destructive phase known as katabolism. These two phases may also be called assimilative and dissimilative, or analytic and synthetic.

It should be understood that these two phases proceed simultaneously; the body is constantly being worn out, and constantly being rebuilt.

Balance of Anabolism and Katabolism.

Throughout the greater part of life, anabolism tends to balance katabolism, provided there is a balance between the intake of supplies and the utilization of them in activities. In the healthy person of normal habits, as fast as cells use their chemicals, more are taken in, more energy is used, again more are taken in, and so on.

Katabolism would, however, exceed anabolism if it were not for stated periods of lessened cell activity during which the rebuilding process predominates. Some of these interruptions in activity occur automatically—for example, the pauses between heart beats. Others must be introduced voluntarily—for example, the intervals between one time of eating and digesting, and the next; and the intervals between one working day and the next.

To maintain the normal balance, katabolism must be prevented from taking place to a degree that no amount of anabolism could balance. The "weakening" effect of sickness is to a considerable extent due to the fact that it often causes the general katabolism to be greatly increased. Finally, the disintegration of old age occurs —a state in which the body's rebuilding powers have waned, and katabolism cannot be balanced by anabolism.

Up to the time when full growth has been attained, anabolic processes must exceed katabolic, in order to provide not only for the activities of daily life, but also for the body's growth in size. This accounts for the fact that the growing child needs more sleep than the adult, and more food in proportion to its size.

At any age, the principle of cell depletion and cell repletion is at work. A judicious degree of wear and tear, with a judicious degree of rest and a judicious choice of food, promotes equilibrium between these two processes.

Chemical Processes in Cells.

Many and varied are the changes that the cells make in the raw materials they take in in the form of food, oxygen and water. How these substances become converted into the special form of protoplasm composing the different cells and into the special products of the cells, is a subject beyond the scope of this volume. However, the basis of all activity is having energy to act. Therefore the process by which cells derive energy may be considered as the

fundamental chemical process involved in metabolism. The source of energy is oxidation.

Oxidation and Energy Production.

Oxidation is a familiar process in many aspects of everyday life. It consists of the uniting of a substance with oxygen; hence the term oxidation. During the process, heat is produced; hence it is also called combustion, or simply burning. This is the process that occurs whenever fuel is burned. Lavoisier in 1770 in France began the experiments that revealed this fact, which has since had a tremendous influence upon civilization.

In the body, combustion occurs on precisely the same principle as in any burning. Fuel substances in cells unite with oxygen brought to them through the blood, and during the process heat is generated.

On first thought, this would appear to account only for the warmth of the body, not for its energy. The rest of the story is that combustion represents a shattering of energy-containing molecules, and that stored energy is released at the same time that heat is produced. The candle when it burns emits light as well as heat. In a motor car, the combustion of gasoline causes an enormous rise of temperature in the cylinders and at the same time an up and down motion of the pistons, which turns the drive shaft and propels the car.

In the body, combustion provides potential energy, of which some is used at once for the various kinds of work of cells and organs and of the body as a whole, and some is held in reserve for future use at need.

A combustible material is one that has a relative lack of oxygen, and an affinity for it. The three foodstuffs—protein, fat and carbohydrate—are the combustible materials used by the body.

Starvation consists of a lack either of combustible material or of oxygen, the agent of combustion. When food is not supplied from the outside, the body is able to oxidize its own substance as fuel, until the supply is gone. However, oxygen must be supplied moment by moment, or life ceases.

The chemical end-products of oxidation are water and carbon dioxide. Both enter the blood, and an excess of either is excreted (by the kidneys, the lungs or the skin).

The Work of the Cells.

With the energy produced in them and available for them, the cells all are alike in carrying on their own nutritive processes. Also, many of them have special work to do in the body economy.

Among the specialized functions of cells may be mentioned the following:

a. Conduction.—The protoplasmic property of conductivity is especially well developed in nerve cells. They are known as the most highly specialized body cells, because they perform one function better than any of the other cells, and in their specialization have lost some of the other protoplasmic properties. For example, some of them are not able to repair themselves.

b. Manufacture of Fluids Necessary to the Body.—There are many different varieties of epithelial cells that are minute chemical factories, taking in chemicals, making them over into new substances, and giving off the product either upon a surface (e.g. saliva), or into the blood (e.g. thyroid gland secretion). These are known as gland cells, and their products as secretions. Gland cells are grouped either in a membrane such as the skin, or in solid organs such as the salivary glands or the thyroid gland.

c. Manufacture of Fluids to Be Excreted from the Body.—The process is exactly the same as that of secretion, and is carried on by gland epithelial cells. The only difference is that in one case the product is of value, and in the other, it is not.

d. Motion.—The muscle cells exhibit to a high degree the protoplasmic property of contractility, whereby they become shorter and wider. As each cell contracts, so also does the whole muscle, or the whole tissue containing muscle fibers.

Various other sorts of specialized cellular work will be mentioned in other connections.

Reproduction of Cells.

All cells originally have the power of reproduction, and some retain it through life. In each living cell (except mature red blood cells) is a roundish body called a nucleus. This is the germinating portion of the cell, which gives it its reproductive power.

All the body cells increase in number during the growing period of life. Each cell simply divides into two new cells, which then attain full size. After the body has reached its full growth, only a few kinds of cells continue to reproduce regularly. Among them are the blood cells which are constantly being destroyed and replaced by new ones. Also, the outer layer of skin is constantly being shed and new cells being developed in the deeper layers of the skin. Many other kinds of cells are able to reproduce under some circumstances, the most important of which is the need for new cells to take the place of cells that have been destroyed.

Disorder of Cells.

When a person is not well, it is his cells (some or all of them) that are not well. The destruction or imperfect working of any considerable number of cells is harmful to the body. In the case of some strategically situated cells, a very slight change in their structure or their behavior may even result fatally.

It is obvious that cellular health cannot be normal unless provision is made for all the chemicals that the cells need, and also for the removal of all the waste chemicals. The life processes suffer as much if the end-products of chemical activity are not removed as they do if they have not adequate supplies. This is particularly true of an excess of carbon dioxide and of nitrogenous waste.

Other causes of disorder of cellular health (and thereby of bodily health) are mentioned in Chapter 4.

Synthesis of the Body.

In the process of development of the body from the single cell, the body constantly becomes more and more subdivided as it becomes larger and larger. But the body is at all times one, and must act as one. That means that there must be a corresponding synthesis of its many cells into one coordinated whole.

a. Organs.—The first step toward synthesis is the combining of various tissues in an orderly fashion to form organs, each organ performing a function that no single tissue could perform. For example, the various tissues that compose the stomach enable it to do several acts that together perform the stomach's part in the total nutrition of the body.

An organ may be defined as a structure composed of two or more tissues, and having a special and definite physiological function to perform for the body economy.

Some organs (in fact many) perform more than one function. For example, the skin is an organ for the protection of the underlying soft parts from injury; an organ to secrete fluid to evaporate on the surface to cool the body; an organ to store fat, as an emergency supply of food; etc.

b. Systems of Organs.—Throughout the body, various organs carry on work in conjunction with each other. For example, the stomach works in association with several other organs. Even an entirely satisfactory stomach would not be able to complete the elaborate process of digestion. It does only a part of the work, and other organs are necessary to do what precedes stomach digestion, and what follows it. There is, therefore, an aggregation of organs,

called the alimentary apparatus or system, for the combined purpose of dealing with food from its entrance into the body until its final disposition.

The term system means a *methodical arrangement.* There are many such systems in the body. One might list as many systems as there are functions to be performed for the body economy (e.g. regulation of body temperature, blood-forming, etc.). However, according to the traditional grouping, as used in the next chapter, five of the ten systems are classified according to function (alimentary, respiratory, excretory, circulatory, and reproductive). The other five are classified according to anatomical structure (skeletal, muscular, nervous, tegumentary, endocrine).

In most of the systems there are several organs. In some cases, the same organ takes part in the work of more than one system, (e.g. the liver is usually classified with the alimentary system, but it has important functions in connection with other systems).

Coordination.

The unified, harmonious action of all parts of the body is a most remarkable phenomenon. That any one cell can act as it does is remarkable enough, but that millions of them should be able to act simultaneously in such a way that one need not even be aware of their functioning would be beyond comprehension if one knew nothing of the means of coordinating all this activity.

The various parts of the body are in constant relationship with each other in two ways: by means of chemicals, and by means of nerve impulses.

a. Chemical Coordination.—There are many chemicals produced in the body that enter the blood, circulate in it, and as they are delivered to cells have the power to excite or to check their activity. They are called hormones. Chief among the hormones are the secretions of the endocrine glands.

Chemical regulation of body processes is sometimes called humoral (*humor*, moisture).

b. Nerve Coordination.—All cells in the body respond to the nerve impulse, which is an electrochemical force that reaches them through the nerve fibers with which they are in contact. Millions of coordinating impulses are travelling along nerves all the time, governing the behavior of individual cells and of organs, and of the whole organism in relation to the environment. The latter is made possible because some of the cells are adapted to receive impressions

from the exterior (e.g. in the skin are receptors, or receivers, of touch sensations; in the eye, of light; in the ear, of sounds, etc.).

Health and Harmony.

Nerves and hormones are very closely related in their work; all parts of the body are affected by neural and chemical impulses. Furthermore, nerves are affected by hormones, and hormone-producing organs are affected by nerve impulses. Finally, both systems of regulation are affected by conditions throughout the body. Briefly, no organ can be deranged without disturbing to some degree the system to which it belongs; and no system can be deranged without affecting all other systems. Clearly, if health is to be maintained, all parts of the body have to be kept in condition.

The Work of the Body as a Whole.

The general plan of bodily life is: intake of material capable of being used for energy-production; energy production itself; outgo of by-products. Stated in another way, the general plan may be said to be: preparation for action; action itself; recovery from action. Thus, action or the use of energy, is the essential aspect of life. The body itself may be looked upon as a sort of power plant, assembling potential energy, and using it either within the body itself or by the body-as-a-whole as a working unit. The former may be called the body's internal work, and the latter its external work.

a. Internal Work.—The body immediately and continuously uses up the greater part of the energy it generates, as fast as it is generated, in keeping itself going, and thereby able to generate more energy—to continue to maintain itself, and so on, in the process we know as life. The sum total of such use of energy is *self-maintenance.* It would have no significance, however, if it were not for the fact that normally the body produces a surplus of energy, and that this may be used by the body-as-a-whole.

b. External Work.—The surplus energy generated in the body permits it to act as a unit in relation to its external environment—in other words, it makes possible what we know as individual life. All the acts of the total individual are neuromuscular, exhibiting in varying degree a motor and a cerebral component. Their significance is that they may assist in *adaptation to the external environment*—to everything in the universe that is not the individual—so as to survive.

Survival.

Muscle-nerve action is that which distinguishes the higher forms of life. It seems that the whole machinery of living goes on in order that muscle tissue and nerve tissue shall be kept in health, and that these tissues may be used in order to adapt the individual to the conditions of living, and to the continuation of living.

In daily life, some of our motor and mental activity clearly has that biological aim—for example, the motor acts of obtaining food, and the mental acts of learning what foods to obtain and where to obtain them, and of earning a living so as to be able to pay for them. Many mental acts seem only very indirectly aimed toward the preservation of life (e.g. doing problems in trigonometry). Still others are not so much concerned with the material aspects of life as with its psychological and spiritual values (e.g. listening to a Gershwin symphony). Whatever the form of their activity, however, the biological significance of mind and muscles alike is the adaptive possibilities they afford.

Chapter 3

THE SYSTEMATIC WORK OF THE BODY

SKELETAL SYSTEM

The skeletal system consists of 206 bones of various sizes and shapes. (See Fig. 18.) It supports the body as a scaffolding, and forms part of the protective enclosures for most of the organs. These are its mechanical functions. It also has a physiological function, that of producing red blood cells in the marrow within bones.

Bones come into relationship with each other at joints (i.e. articulate with each other). Motion is possible at many such articulations. When motion occurs at a joint it is because of contraction of skeletal muscles attached directly or by tendons to the bones on either side of the joint. The same contraction, when equalized,

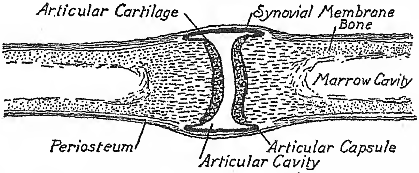


FIG. 17.—Diagram of a hinge joint such as the knee.

serves to prevent motion from taking place. Cartilage is interposed between the ends of the bones in joints, to give resiliency in motion. In and around joints are firm bands of fibrous tissue, called ligaments, which help to hold the ends of the bones in the normal relationships to each other.

To have normal action at a joint, the formation of the bones that make the joint must be normal; the lubricating epithelium that lines the joint must moisten it just enough and not too much; its cartilages and ligaments must have normal strength and elasticity; and the muscles that control its motion must be strong and correctly used, so as to keep the joint firm while permitting the normal range of motion.

The type of motion at joints depends upon the formation of the joint. Hinge joints, such as those in the fingers and toes, wrists,

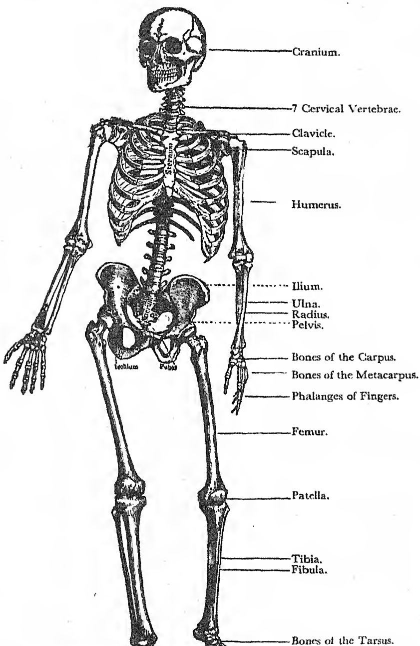


FIG. 18.—The skeleton. (After Holden.)

knees, etc., permit flexion and extension. Ball and socket joints, such as the shoulder, permit rotation and circumduction.

At birth, the bones are formed of cartilage. They are soft because of a lack of minerals in them. Gradually, during childhood and youth, if the diet provides them, minerals are deposited in bones and

they become hard. The change from soft cartilage to hard bone is known as the process of ossification (bone formation).

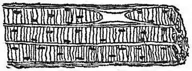
Throughout life, the health of the bones depends upon a diet containing certain materials (phosphorus, calcium and vitamin D) and certain chemicals from endocrine glands which regulate their growth and the deposit of minerals in them.

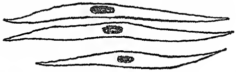
MUSCULAR SYSTEM

All muscle tissue has the following properties: contractility, or the ability to become shorter and wider; extensibility, or the ability to be stretched; elasticity, or the ability to recoil after being stretched; and tonicity, or being always ready to act, or never entirely relaxed. (The latter is a property of smooth muscle and is supplied to skeletal muscle by functional contact with its motor nerves.) In the body, contraction of muscles takes place largely in direct response to the stimulus of motor nerves.

A. Skeletal Muscles.

There are over 500 muscles arranged about the skeleton, to produce motion of its parts and locomotion of the whole. Each


Voluntary muscle cells


Involuntary muscle cells

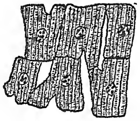

Heart muscle cells

FIG. 19.—Muscle cells.

muscle consists of small bundles of muscle cells encased in fibrous tissue, the whole surrounded by a fibrous sheath. At one end the muscle is usually attached directly to a bone, and at the other end to another bone by a tendon, which consists of a prolongation of the fibrous tissue of the muscle.

Muscle contraction causes motion at joints, since the shortening of the muscle brings its two ends nearer together and decreases the angle between the bones to which it is attached. Many of the skeletal muscles are arranged in antagonistic sets on opposite sides

of a joint, one set causing flexion and the other extension; when one set contracts and the other relaxes, motion takes place, and when both sets contract equally (or neither contracts), no motion occurs. The function of some of the skeletal muscles is that of enclosing cavities and protecting organs (e.g. abdominal muscles, which require constant contraction in order to serve their purpose of holding organs in place).

All skeletal muscles are voluntary (i.e. under the control of the will), but they may be used in an almost involuntary fashion as a result of habit (e.g. walking), or at times in an entirely involuntary

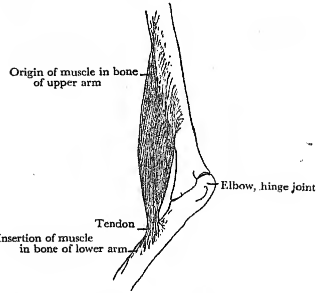


FIG. 20.—Origin and insertion of one of the flexor muscles of the arm.

reflex way (e.g. swallowing; winking). Also, as a result of lack of attention and practice, certain muscles, although voluntary, may not be actually controlled (e.g. abdominal muscles; muscles controlling motion of the ears; etc.).

In connection with their motor function, skeletal muscles also serve several other purposes, as follows.

(*a*) All muscles carry on chemical reactions involving oxidation of glycogen from food, whereby they generate energy in the form of heat and motion, and give off carbon dioxide and lactic acid. Since the skeletal muscles are large and numerous, they are by far the largest *source of body heat.* They have been called the "fireplaces" of the body. (*b*) As has been mentioned, muscles use glycogen; it is also true that they store glycogen for future use. In fact they are the chief *fuel storage places.* (*c*) When skeletal muscles contract, their increased circumference causes increased pressure upon the soft-walled veins that lie near them or pass through them.

The result of such pressure is that the blood in the veins is forced out of them in the only direction it can flow, toward the heart. Also, when muscles contract they require so large a quantity of blood that the heart action and the circulation in general is increased. In these ways the muscles have the function of *promoting circulation.*

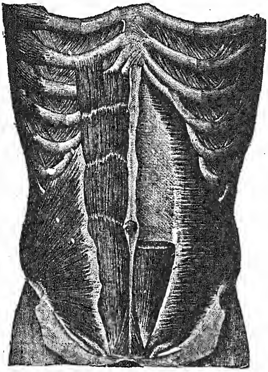


FIG. 21.—Some of the muscles of the chest and abdominal wall. (Bundy.)

B. Visceral Muscle.

This term is applied to muscle tissue such as that in walls of hollow organs and tubular structures (*viscera*, organs). Such muscle, when it contracts, changes the shape of the organ in which it is found, usually with the result that the contents of the organ are compressed and extruded from the organ or moved onward within it. This is the function of the muscle tissue in, for example, the food tube, the bladder, the uterus, etc. At some of the openings of the body, visceral muscle forms rings, or sphincters, whose contraction retains the contents and whose relaxation permits the contents to be extruded (e.g. sphincters at the outlet from the large intestine and from the bladder).

Visceral muscle is also found in the walls of the arteries, in which location its elasticity is its most important property. Such muscle fibers are passively stretched at each beat of the heart, and recoil immediately afterward.

Because of its microscopic structure, visceral muscle is also called *smooth* muscle, and because it is not under the control of the will, it is called *involuntary* muscle. Nearly all visceral muscle is involuntary. Exceptions are the sphincters that are subject to varying degree of voluntary control.

C. Heart Muscle.

A special type of muscle composes the greater part of the heart. It contracts involuntarily and regularly (normally 65–75 times per minute), to press the blood from one of its chambers to the next, and finally outward into blood vessels.

TEGUMENTARY SYSTEM

The outermost layer of the body is the skin, which is continuous at the body apertures with a pinkish tissue called mucous membrane. The latter extends within the body. A continuous sheet of it lines the whole of the respiratory and the digestive tracts; another sheet of it lines the whole of the genital and urinary tracts. A similar membrane lines all closed cavities (e.g. the peritoneal cavity, or

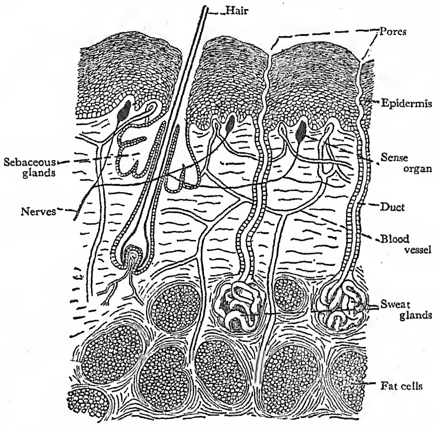


FIG. 22.—A section through the skin to show its structure. Note the sweat glands with long tubes, and the position of the sense organs just beneath the epidermis. (Modified from Folsom.)

cavity of the abdomen, the joints, the skull cavity, etc.) and also encases the organs.

All membranes, including the skin, are for mechanical protection of the parts they cover. Also, all secrete fluid. In the interior of the body this fluid acts as a lubricant between moving parts (e.g. in joints; between the lungs and the chest wall). Some of the membranes have additional functions (e.g. the mucous membranes of the intestinal tract produce not only mucus but also certain of the digestive juices). The skin, in particular, has several additional functions.

The skin consists of many layers, the outermost cells being thin, flat and dead. Skin cells reproduce rapidly; the lowermost layers grow and the outer dead cells are constantly being shed.

Deep in the skin are secretory glands of two sorts, producing two secretions, sweat and sebum, which are carried to the surface by ducts ("pores"). Sebum is an oily substance to keep the skin pliable and, to some extent, waterproof. Sweat is largely water, and its main purpose is that of evaporating on the surface, thereby cooling it and lowering the body's temperature.

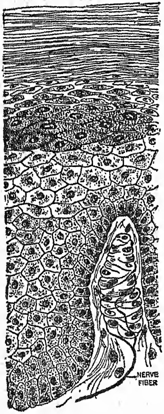


FIG. 23.—Touch corpuscle in the skin. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

The skin is an important storage place. First, fat is deposited in considerable quantities in its deeper layers, especially in women (the panniculus adiposus). Second, a sugar called glycogen is stored in it to a limited extent. Both of these substances serve as "emergency rations" which may be called forth into the blood and burned as fuel in case of need. The fat also serves as insulation against cold. Also, a variable amount of water is stored in the skin, as a reserve supply. Finally, vitamin D, which is produced in the skin as the result of exposure to direct sunlight, remains there for a time, whence it is given off little by little to the rest of the body, for nutritive purposes.

NERVOUS SYSTEM

Afferent and Efferent Messages.

The principle of the nervous control of the body is that of communication to and from all parts of the body by means of nerves. Generally speaking, nerves run *from* every cell *to* certain nerve centers in the brain and spinal cord; and other nerves run *to* every cell *from* these centers outward.

The nerves that carry in-going communications are called *afferent* (carrying toward), and those that carry out-going communications are called *efferent* (carrying outward). (The prefix in each case has reference to the centers in the brain and spinal cord.)

Afferent Nerves.

Afferent nerves are sensory—that is, they carry sensation. The senses are: vision, hearing, taste, smell, touch (the "five senses"), and also pain, temperature (warm and cool), equilibrium, kinesthesia (the sense of position and motion, due largely to muscle, joint, and tendon sensitivity), and various organic sensations which we know in blends such as hunger and thirst. In general, the sensory

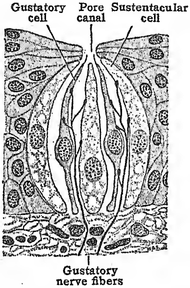


FIG. 24.—Diagram of the structure of a taste-bud. ×475. (Morris.)

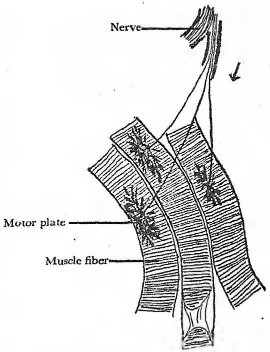


FIG. 25.—Motor end-organs in voluntary muscle fibers, through which the muscle receives impulses for contraction.

nerves have special end-organs or receptors adapted to receive only one kind of sensation and not others. For example, certain cells in the eyes are the receptors of the optic (eye) nerves. These, and some of the other senses carry "information" from the outside world; whereas kinesthetic and organic sensations carry information regarding the body itself. Some of these sensations are not regularly felt as such.

Efferent Nerves.

The efferent nerves carry action messages to the muscles and the glands, bidding them to act or not to act, as the case may be; and to the body-as-a-whole, to behave or not to behave in this way or that. The term *inhibition* is applied to the checking of action. It should be noted that it is as important as *activation.*

Reflex Action.

All bodily functions are in this manner regulated by the nerves; upon "information received," headquarters issues "orders." Moment by moment, all the vital functions perform their work upon this principle, and the normal person knows nothing of their workings unless something happens to disturb the quiet harmony. For example, a due amount of blood is provided to the organs that need it most, the rate of breathing is kept suitable for the body's need for oxygen, the rate of the heart is regulated so that blood circulates with the required rapidity, motion in the digestive tract takes place at the proper time, etc. All these matters are automatically regulated by reflex action. This means that nerve impulses take a short and direct route through afferent nerves, to the centers, and out

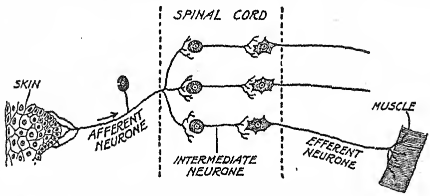


FIG. 26.—Scheme of a Simple Reflex Arc. (Winton and Bayliss "Human Physiology.")

again over efferent nerves—the whole process going on "of its own accord," without any voluntary direction.

Although reflexes usually take place unconsciously, sometimes they can be observed. For example, when the skin blood vessels become dilated with blood on a hot day, it is because of reflexes which send the blood to the skin to be cooled by the atmosphere, yet one is aware of both the heat of the day, which starts the reflex, and of the redness and heat of the skin, which result from the reflex.

Reflex action governs not only organ activity but many of the acts of the skeletal muscles, notably their control over posture. Similarly, the eyelids reflexly close to shut out a cinder, the hand reflexly draws away from a hot object, the whole body shivers with the cold, or shudders with horror.

Conditioned Reflexes.

Reflexes may be conditioned, or caused to appear regularly in certain other conditions than naturally produce them. This was

first demonstrated by the physiologist Pavlov, regarding the reflex flow of saliva. Normally this is excited by food—the sight or smell or taste or thought of it. But in the case of dogs if a bell is always rung at the same time that food is offered, eventually the bell starts the reflex flow of saliva even when no food is offered. The same conditioned reflex often occurs in humans, and so also do many others.

Voluntary Action.

The nervous system produces another sort of action, known as voluntary. It differs from reflex action in that it involves more complex action of the brain. To illustrate; if a person attempting to

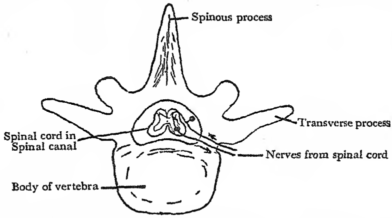


Fig. 27.—Cross section of vertebra and spinal cord, showing spinal nerves.

cross the street in traffic, looks around and sees a car coming, and decides to stand where he is until it has passed him, he has committed a voluntary act. But if he inadvertently steps in the path of an oncoming car, and his legs cause him instantly to step backward at the precise moment he sees the car, his nervous system has caused him to commit a reflex act.

It appears that the difference between a reflex and a voluntary act may be that the latter involves a spacing between an incoming and an outgoing nerve impulse during which thinking goes on.

Habit.

A voluntary act may be repeated so often that it becomes virtually a reflex act. For example, driving a car may take place after long experience almost as reflexly as organ processes. The sensory impressions of sight and hearing and of touch and position may be relayed to the brain and spinal cord, and appropriate impulses be quickly forthcoming to guide the muscles used in driving. The term habit may be applied to acts which have been learned but are carried on in an automatic way.

Nerve Tissue.

Communication throughout the body is made possible because of the nature of nerve tissue. The nerves themselves are bundles

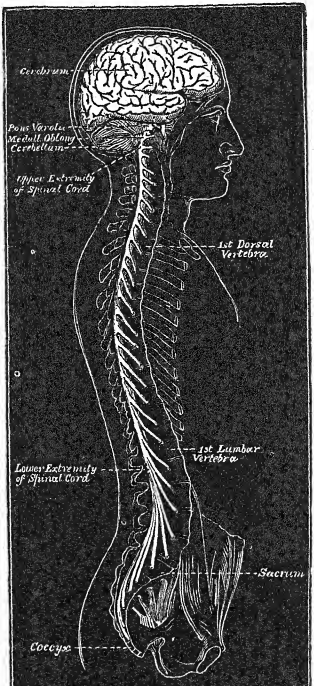


FIG. 28.—The cerebro-spinal axis of the nervous system, showing the spinal nerves cut at the points where they pass out from the dorsal cavity. (Halliburton "Handbook of Physiology.)

of nerve fibers connected with nerve cell bodies, located in the brain and spinal cord and in certain structures (ganglia) connected

with them. Each nerve cell (neuron) consists of a cell body and fibers given off from it—one long fiber (an axon) and many shorter ones (dendrites). The axons from numerous cells are carried in cables, analogous to cables of telephone wires. These cables constitute the nerves. Near its origin, each nerve contains a myriad of fibers, but as it branches and rebranches, the number becomes constantly smaller. Each branch finally ends as a single fiber, microscopic in size, and each is in contact with a cell, from which it receives impulses or to which it transmits impulses.

The characteristic of the nerve cell, all parts of it, is its conductivity. All protoplasm, therefore all cells, are to some extent

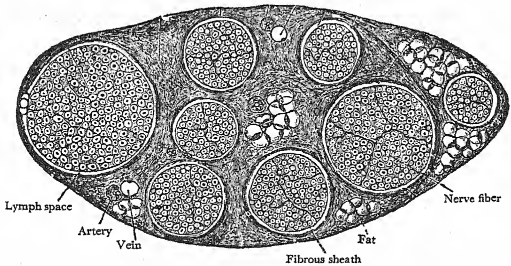


FIG. 29.—Cross section of nerve ×100. Bundles of nerve fibers in sheath of fibrous tissue. (Halliburton "Handbook of Physiology.")

conductive. But in the multicellular organism, the particular tissue composing the nervous system has specialized in conduction.

Stimulus and Response.

Conduction in nerve tissue starts when something affects the tissue in one spot. At that spot internal electro-chemical changes take place, which spread by successive electro-chemical reactions throughout the cell in a given direction. The "something" that starts the conduction process is called the stimulus. Stimuli that excite nerves vary according to the nerve ending. For example, light is, of course, the stimulus of the optic nerve. All nerves may be stimulated by electrical current.

After a stimulus has acted upon the ending of an afferent nerve, and conduction to its center has taken place, the impulse set up in that center is conducted to the cell body of an efferent nerve, and through its fibers to a muscle or a gland, which thereupon responds.

The final result of a stimulus applied to an afferent nerve is, thus, a reaction brought about by an efferent nerve.

The response to a stimulus may be overt action of the muscle or gland—that is, the muscle contracts or the gland secretes. Or it may be inhibition of action—that is, the muscle relaxes or the gland

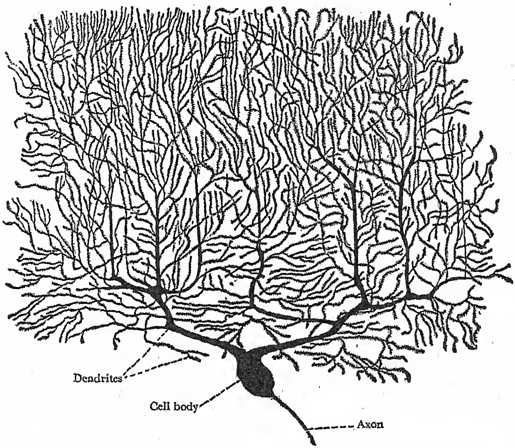


FIG. 30.—Purkinje cell from human cerebellum. Golgi's method of staining. (Stöhr.)

ceases to secrete. An example is the rate of the heart beat, which is increased by one effector nerve and checked by another.

Association Neurons.

The route of even the simplest reflex is probably never directly from an afferent to an efferent neuron. Instead, it passes through one or more intermediate neurons. These are known as association neurons, for the obvious reason that they bring neurons into association with each other. They are also known as connector neurons. The term synapse is used to describe the point at which impulses pass between axons of one neuron and dendrites of another.

In the centers (the brain and the cord) lie uncounted millions of cell bodies, each having a vast number of fibers to bring it into synaptic relationships with as many other cell bodies, each with as

many fibers. The possibilities of neuron association are an astronomical figure to the *n*th degree.

Nerve Centers.

Yet there is order in the arrangement of the neurons. Science has been able to determine just where the cells serving certain functions lie, and just what pathways their fibers follow in the brain and the spinal cord. The centers for the special senses and for the general sensitivity of the body have been charted as shown in Fig. 182. When sensation is experienced, it is because nerve action has reached sensory centers in the cortex of the brain. The cortex is the outer layer of the brain. It is composed of cell bodies that are gray in color, hence is called the "gray matter." In it are not only the sensory centers, but also the center from which voluntary motion of the skeletal muscles is controlled. It will be noted that the cortex is concerned in sensations that are experienced and in acts that are voluntarily directed.

Much activity of the body is, however, unperceived and involuntary. As has been mentioned, throughout the body there is a great deal of involuntary or visceral muscle, and a great many glands. Involuntary muscle is found in the walls of tubular structures such as the blood vessels and the digestive tube, and in the walls of hollow organs such as the stomach, the bladder and the heart. Among the glands are those in the skin and all the mucous membranes, the tear glands, the salivary glands and all the endocrine glands. All vital functions are performed either through contraction of smooth muscle or secretion of glands. And all these functions are directed from centers below the cortex of the brain.

The central control of some of the vital processes is in centers at the base of the brain and in the lower end of the brain stem (medulla). There are special centers for the regulation of the heart rate, for respiration, and for body temperature.

Many body processes are controlled chiefly by reflexes that do not regularly include brain neurons—that is, the reflex arc is commonly into the spinal cord and out again. But even in such cases, affector impulses may travel to the brain, and effector impulses from the brain may take part in the response. This is the case, for example, regarding sphincter control of the bladder and the intestines.

Autonomic System.

For the most completely automatic functioning of the organs there exists a special set of centers and nerves called the autonomic

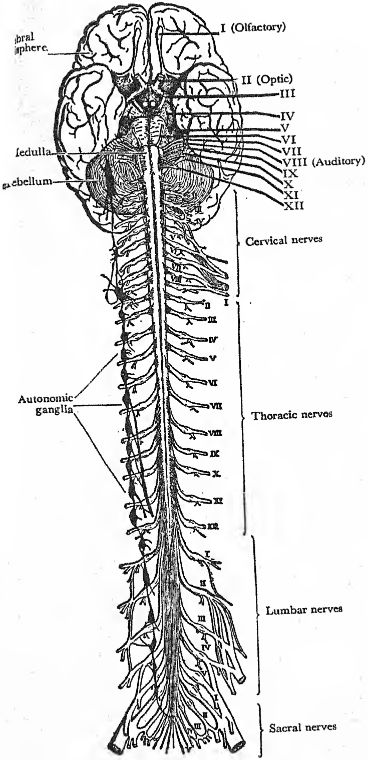


FIG. 31.—Diagram of base of brain and the spinal cord, showing origin of cranial and spinal nerves. (Morris.)

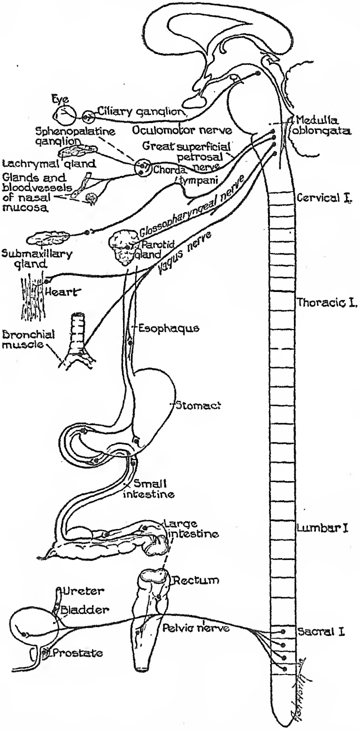


FIG. 32.—Some of the organ activity under the direction of the autonomic system. (Larsell, Textbook of Neuroanatomy and Sense Organs. D. Appleton-Century Co., 1939.)

nervous system. It consists chiefly of a series of nerve centers called ganglia, 49 in number, located in two chains in front of and parallel to the spinal column. The ganglia are connected by nerve fibers with each other, with the spinal cord, and with glands and involuntary muscle in numerous tissues and organs.

Organ activity is entirely a reflex matter, with its effector impulses flowing through the autonomic ganglia. The term autonomic means "a law unto itself." This is an appropriate term in so far as it indicates that the organs act quite without any voluntary direction. But it is an unfortunate term, in that it does not tell the whole story.

On the sensory side of the reflex arc, impulses from organs often do reach the brain—as, for example, in the case of the stomach when it is empty and demanding food, or when it is too full and having difficulty. Many specific sensory impulses from the organs actually do reach consciousness, especially when there is something of a voluntary nature that may be done to set them right. Similarly, even on the effector side, the autonomic impulses may be greatly affected by impulses from the central nervous system. For example, the sight or smell or even the thought of food may start the flow of saliva; excitement may check saliva and dry the mouth, or cause over activity of the muscles in the intestinal tract.

Furthermore, even though the autonomic functions are not subject to *direct* control by the will, they are to a considerable extent subject to *indirect* control. Often one may voluntarily set the conditions that favor smooth autonomic functioning. For example, by taking a correct diet, and having calm at mealtimes, one favors the quiet and harmonious process of digestion. In fact, the study of hygiene is to a considerable extent for the purpose of learning how to regulate indirectly these processes that are automatic—in other words, to put a law above these organs that are "a law unto themselves."

Adaptation.

The nervous system brings every part of the body and the mind into relationship with every other part, and under favorable conditions tends to make these relationships favorable for the survival of the organism. It serves as an *internal* adaptive mechanism, functioning in harmony with the other adaptive mechanism, that of hormones. Also, since it is the main means whereby we come into relationship with the *external* environment—since we acquire infor-

mation regarding the environment through the afferent nerves, and adjust to it through the various efferent pathways—the nervous system is therefore the supreme adaptive mechanism. And in the nervous system itself, the cortex of the brain ranks supreme.

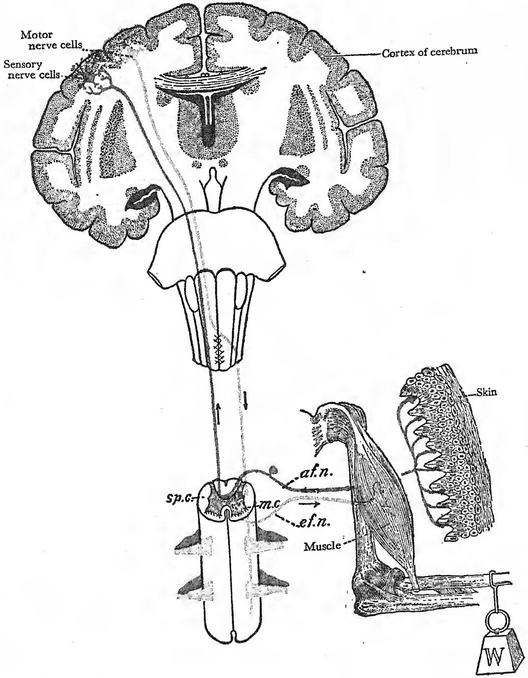


FIG. 33.—Diagram showing afferent (sensory) nerve tract from skin, to spinal cord, to cortex of the brain (blue line); and efferent (motor) nerve tract from cortex of the brain, to spinal cord, to muscle (red line). (From Bundy's "Textbook of Anatomy and Physiology.")

CIRCULATORY SYSTEM

This system has often been called the transportation system of the body, since it consists of a series of closed tubes through which materials in solution are carried from part to part throughout the body. Two fluids are circulated thus—blood and lymph.

The *blood circulatory system* consists of the heart, a hollow muscular organ which contracts rhythmically, acting as a pump to force blood into the arteries. The arteries carry blood away from

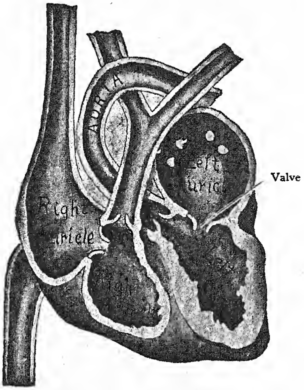


FIG. 34.—Chambers of the heart, showing valves. (From Farr, "Internal Medicine for Nurses." Courtesy of Lea and Febiger Publishers.)

the heart, to each and every part of the body; the veins bring it back again to the heart.

The *heart* consists of four chambers, with valves so arranged as to keep blood flowing in the right direction (i.e. to and from the body as a whole and to and from the lungs). It usually contracts from 65–75 times per minute in adults. The beat of the heart against the left chest wall may usually be felt. The pulse is the impact of the blood against artery walls at each beat of the heart; it may be felt in arteries near the surface, as at the wrist.

The main artery leading from the heart is called the aorta. From it, many branches are given off. These branches give off other

branches, and so on. The smallest branches (arterioles) are so small that they cannot be seen by the naked eye. They are continuous

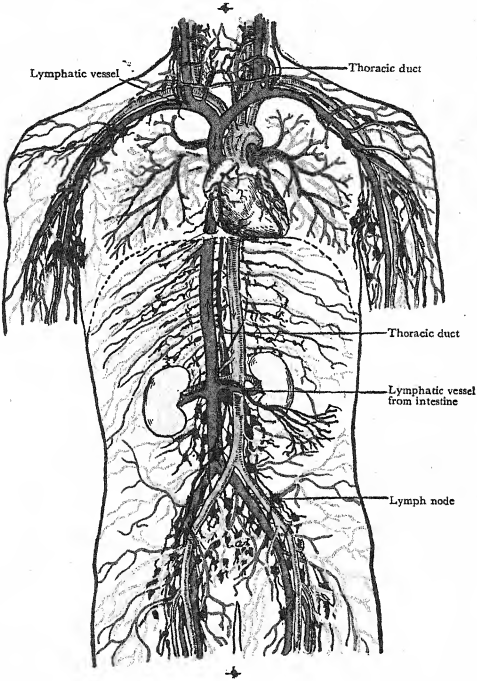


Fig. 35.—The heart and the main blood vessels of the body, arteries in red, veins in blue; and the lymph vessels, with lymph nodes along their course, in black. Infection may be carried by either blood or lymph. (From Ritchie's Human Physiology, Copyright 1920 by World Book Company, Publishers, Yonkers-On-Hudson, New York.)

with still smaller blood vessels, the capillaries, and these are continuous with the small veins, then larger veins, and finally the largest veins, which empty into the heart. From the heart to any given

point in the body, *circulation* of the blood takes place through this series of closed tubes.

The ultimate circulation of the blood is between the capillaries and the cells near which they flow. Nutritive substances pass from capillaries to cells, and waste substances pass from cells to capillaries.

A special circulatory system (pulmonic) extends from the heart to the lungs and back again. After each trip through the general circulation, blood goes to the lungs to rid itself of carbon dioxide and to take on oxygen.

Another special circulatory route is from the intestines to the liver and then to the heart (the portal, or liver, circulation), its function being to make nutriment quickly available.

The *blood* is a fluid tissue, consisting of the plasma, in which float red cells, several kinds of white cells, and platelets. All its cells are formed outside the circulatory system (in the spleen, bone marrow, and elsewhere) and enter through the capillaries in the organs where they are formed.

Besides the blood cells, the materials transported in the blood plasma are: first, nutritive materials received from the digestive tract; second, oxygen, received from the lungs; third, chemical regulators (hormones) received from the endocrine glands; fourth, waste from all cells, to be taken to the lungs and the kidneys for excretion from the body; fifth, fibrinogen, one of the blood's own constituents, which causes shed blood to clot; and sixth, a large percentage of water. In addition, the blood of a person immune to a given disease contains the particular chemicals (antibodies) that give him that immunity.

At one time or another, the blood in a given individual may contain other materials, for whatever actually enters the body is likely to enter the circulation. This is the case, for example, with bacteria and their toxins, or chemicals taken in through the digestive tract or inhaled through the lungs. It will be seen that the transportation system carries a variety of freight, and, to carry the figure further, that each body cell may be looked upon as a freight station at which loading and unloading take place.

The red blood cells are the oxygen carriers. They contain an iron-bearing substance called hemoglobin. In the lungs, oxygen passes through the capillary walls, to unite with hemoglobin in red cells. Later, oxygen passes from the red cells into each and every cell in the body, for use in combustion and energy production.

The white blood cells or leucocytes are of several sorts. Many of them act as phagocytes ("devourers"). Leaving the capillaries and

collecting in injured areas, they act upon injuring agents, such as bacteria and destroyed tissue, often in such a way as to render them harmless.

Platelets are tiny cells which take part in the clotting of blood.

The *lymph circulation* is an adjunct to the blood circulation. Lymph is formed in the tissues, and is carried to the heart. Between the cells in all the tissues, there are minute spaces containing a small amount of fluid. This fluid comes partly from the cells and partly

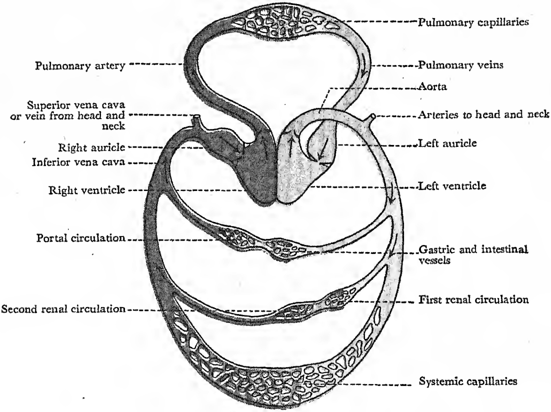


FIG. 36.—Diagram of the circulation; blood flows in the direction of arrows. (Halliburton.)

from the blood capillaries in the region. Some of this fluid (lymph) again enters the capillaries and proceeds via the veins to the heart, but part of it enters closed tubes, the lymph vessels, which originate in the lymph spaces. The microscopic lymph vessels unite to form somewhat larger ones, and these to form still larger ones, and so on, until finally they form several large vessels that empty into veins near the heart or into the heart itself.

Along the course of the lymph vessels are structures known as lymph nodes. They contain phagocytic cells and act as an important means of retaining and destroying harmful material drained from the tissues in the area from which their vessels come. Also, they

produce some of the white blood cells. The tonsils and the adenoids are lymph structures, similar to lymph nodes.

RESPIRATORY SYSTEM

By means of the respiratory system, oxygen from the air is delivered to all body cells, and carbon dioxide from cells is removed from the body. The air breathed in contains about 21.0% oxygen

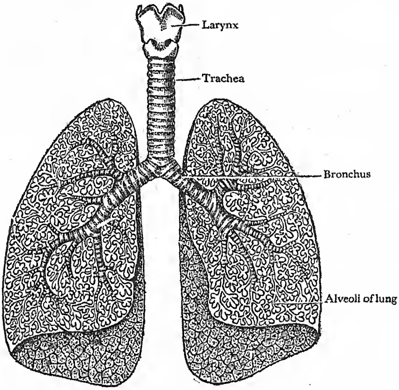


FIG. 37.—Diagram showing the larynx, trachea, bronchi and lungs. (Bachmann and Bliss.)

and 0.04% carbon dioxide, as against 16.6% oxygen and 4.4% carbon dioxide in expired air. All cells of the body require oxygen for combustion and energy production; conversely, all give off carbon dioxide. Both these gases are carried in the blood, to and from the lungs.

The lungs are not large single cavities, but are made up of 750,000,000 tiny air sacs, or alveoli. Air entering the alveoli comes in contact with the mucous membrane lining them, in which are capillary blood vessels. In the blood are red blood corpuscles containing an iron-bearing substance called hemoglobin. The iron has a strong affinity for oxygen, and oxygen passes directly through the walls of the alveoli to unite with the oxygen in the red cells. At the same time, carbon dioxide is given off from the blood into the alveoli and then out from the lungs.

The passages leading to the lungs begin with the nose. Its cavities extend backward, and then downward to the pharynx or throat, which leads successively to the larynx, the trachea (windpipe), the two bronchi (one to each lung), the smaller bronchi (one to each lobe of each lung), and finally the bronchioles, each leading into a cluster of alveoli.

External respiration consists of the gaseous exchange already mentioned, between the atmosphere and the blood. A further exchange is necessary, however. As the blood circulates through the body, each cell takes the oxygen it needs, and gives off the waste

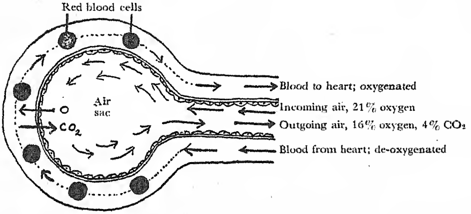


Fig. 38.—Diagram of an air sac of the lung adjacent to a blood vessel. Note the passage of oxygen into the lung and the blood, and the passage of carbon dioxide out of the blood and the lung.

carbon dioxide. This exchange, between blood and cells, is known as *internal respiration*.

The act of breathing is due to the mobility of the chest walls and of the muscle (diaphragm) which extends across the lower chest, separating it from the abdominal cavity. When the chest muscles between each two ribs contract and the diaphragm contracts, the chest becomes larger and air rushes in, as into a bellows. When they relax, the chest becomes smaller and air flows out. Admitting air is an active process; releasing it, a passive one.

Breathing is an automatic process, that goes on, usually, without voluntary attention. It is possible voluntarily to breathe faster or slower, and even to hold the breath, temporarily, but the normal rhythm of breathing reasserts itself shortly. The reflex is governed by respiratory centers in the brain. One factor that influences the rate and depth of breathing is the concentration of carbon dioxide in the blood flowing through the center; the more carbon dioxide to be removed, the faster the breathing, and vice versa.

Organs that are accessories in respiration are the mouth, through which breathing may occur in emergencies, and the sinuses. The sinuses are hollow spaces in the bones of the skull and the face, communicating with the nasal passages. Inspired air flows through all the sinuses, and is warmed and moistened before being taken into the lungs.

Associated with the respiratory tract are the tonsils, small masses of lymphoid tissue on either side of the throat; and the larynx, the vocal organ. The larynx is a box-like structure between the pharynx and the trachea, so situated that the air current from the lungs passes across its "strings," the vocal cords, causing them to vibrate in sound.

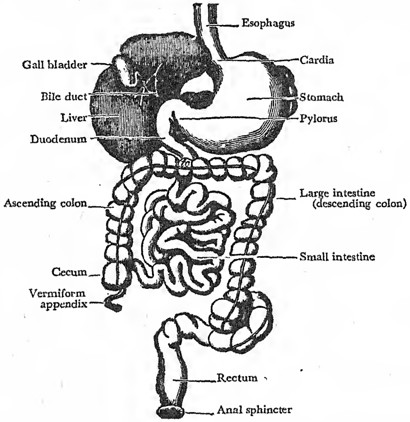


FIG. 39.—The alimentary tract, showing liver turned upward to expose the gall bladder beneath it. (Potter.)

ALIMENTARY SYSTEM

The alimentary or digestive system consists chiefly of a long tube (the *alimentary canal* or tube, or digestive tract) which begins with the mouth and leads successively into the throat, esophagus (gullet), stomach (a widened portion of the tube), small intestine (26–28 feet long), large intestine, colon, or bowel (6 feet long), rectum, and

anus. It also comprises certain *glandular organs* (salivary glands, liver, and pancreas) whose secretions enter the digestive tract.

The work of the alimentary system is to change foods to a form in which they can be absorbed; to absorb the nutrient portions of the food; and to discharge the remainder from the body. It accomplishes this work by the *chemical* action of its digestive juices and by *motor* action of muscle fibers in the wall of the stomach and intestines.

The chemicals that bring about digestion are called enzymes (*to leaven*). An enzyme is a chemical substance produced by living cells, which has the power to transform some other compound. The alimentary system produces several enzymes, each of which acts specifically on one food compound, reducing it to chemically simpler forms.

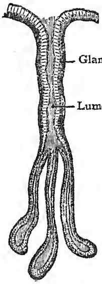


Fig. 40.—Pyloric gland of the stomach. (Bachman and Bliss.)

Chemical digestion begins in the mouth, by the action of the salivary enzyme on starches. It continues in the stomach, where digestion of proteins is begun, by the gastric or stomach juices, secreted by glands in the wall of the stomach. Gastric juice contains two enzymes and also hydrochloric acid, necessary for the action of the enzymes.

In the small intestine, the digestion of starches and protein is concluded, and fats are digested. Enzymes in the small intestine come from the wall of the small intestine itself (the intestinal juice) and from the pancreas (pancreatic juice). The pancreas is located near the stomach, and its juice enters the upper part of the small intestine (the duodenum) by a duct.

For digestion in the small intestine, bile from the liver is also necessary. It flows from the liver into a sac (gall bladder, located under the edge of the liver) where it is stored, and from which it is given off through a duct into the intestine when it is needed for digestion.

The *motor* action on food also begins in the mouth, with chewing. This subdivides food so that saliva can mix with it, to start the digestion of starches. Also, it subdivides protein so that its digestion can be begun in the stomach.

Motor activity in the stomach consists of a churning motion, for mixing food with gastric juice, and a propulsive motion, to discharge food through the pylorus (gate) into the small intestine.

The pylorus opens reflexly from time to time during digestion, after food has reached a semi-liquid state.

In the small intestine, motion is forward and backward and circular. It has the effect of mixing food with juices, favoring the absorption of that which is ready to be absorbed, and little by little moving the remaining mass onward to the large intestine.

Motion is slow in the large intestine. Much of the remaining water is absorbed, with the result that the mass again becomes semi-solid. Eventually, the residue is given off, as fecal material, or feces. Ordinarily, evacuation of the lower part of the bowel takes place every twenty-four hours. The opening of the anus is guarded by two sphincter muscles, which automatically retain the residue until voluntary defecation.

Motion of the stomach and intestines is called peristalsis (constriction around). The name refers to the circular constricting motion of the muscle fibers, which has the effect of pressing the contents onward. Lengthwise wave-like motion also occurs.

Absorption of digested food takes place directly through the walls of the digestive tract into its blood vessels or lymph vessels. The stomach and the colon absorb little except water. Most of the nutriment is absorbed from the small intestine, as fast as digestion is completed.

After entering the circulatory system, nutriment material is carried to all the cells of the body, which take from the blood the substances they need for their maintenance and their activities.

EXCRETORY SYSTEM

This system consists of the two kidneys and the bladder, with the tubes from the kidneys to the bladder (ureters) and the tube from the bladder to the exterior (urethra). It is the only system exclusively for ridding the body of waste.

All cells of the body give off their waste into the blood. Some of this waste would be poisonous if retained. This is particularly true of nitrogenous waste from the breakdown of protoplasm of cells and from nitrogenous (protein) food. As the blood circulates through the body, nitrogenous waste is taken up by the liver, which makes it into a substance called urea. The liver then turns urea into the blood, and as the blood passes through the kidneys, they take urea and many other substances, including water, from the blood and make a fluid product (an excretion) called urine. Urine is constantly being formed and constantly flows from the kidneys into the bladder.

The bladder is an elastic, muscular sac, capable of distending so as to hold a pint or more of accumulated urine. The urethra is guarded by a sphincter muscle that, after infancy, reflexly remains closed except when voluntarily relaxed for voiding the bladder in the act of urination or micturition, which usually occurs four or five times during the waking hours and not at night.

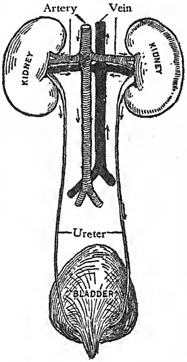


FIG. 41.—The kidneys and the bladder. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

ENDOCRINE SYSTEM

In various places throughout the body are glandular organs which take materials from the blood, change them over, and return to the blood the new products they have manufactured. When this "manufacturing" process was first discovered, the hitherto mysterious glands were named endocrine, which means "to separate within."

Because the endocrine secretions enter the blood and remain in the body, they are called internal secretions, to distinguish them from external secretions that are discharged through ducts to body surfaces (e.g. the digestive juices, sweat, etc.). Some of the glandular organs produce both sorts. For example, the pancreas produces digestive juices that enter the small intestine, and also insulin, which enters the blood.

Each of the endocrine glands produces a distinctive secretion of its own. All are hormones, or chemical messengers. As they circulate through the body they act upon the various tissues and organs and functions, either to stimulate their action or to inhibit them in various specific ways. For example, the thyroid hormone stimulates general metabolism of the body.

Together, the endocrine glands form a system, affecting all the functions of the body. The various glands work in harmony with each other, and the whole system and each gland in it works in harmony with the nervous system in coordinating all life processes.

The glandular organs whose exclusive function is the production of internal secretions are: the pituitary, at the base of the brain; the thyroid and the parathyroids in the neck; and the adrenals or

suprarenals, in the region of the kidneys. Among those that produce internal secretions and also have other functions are: the pancreas, in the region of the stomach; and the gonads or sex glands (testes or testicles, and ovaries) in the pelvic region.

The function of the individual glands is more fully discussed in connection with their disorders in Chapter 12.

REPRODUCTIVE SYSTEM

Reproduction takes place as a result of the union of one sex cell from the male with one from the female. In each sex, the chief organs of reproduction are the glandular structures in which the sex cells are developed (the testes in the male, and the ovaries in the female); the passages through which these cells travel to their meeting place; and, in the female, the sac (uterus) in which the new being (embryo) grows before birth.

The details regarding this system will be given in Chapter 43.

PART 3

TYPES OF BODILY DISORDER

Chapter 4

DISEASE AND RECOVERY

The Term Disease.

All living things, plant and animal, are subject to departures from normal in structure and function. These changes are called disease. The word disease is an old English one, meaning lack of ease. It aptly describes the subjective aspect of bodily disorder, which is usually accompanied by some degree of discomfort. The word is an appropriate one to describe disorder in humans, who, with their highly developed nervous system, become aware of sensory disturbances arising from parts that are "out of order." Less appropriately, it is now used to describe similar disorder in lower forms of animal life and also in plant life, not so constituted as to feel discomfort.

With virtually all disorder in the human body there will be some degree of lack of comfort, either locally or generally. This may not amount to actual pain, but perhaps merely to loss of the sense of physical well-being. It is difficult to mention a single disease, except perhaps baldness, that does not cause discomfort. Whether an individual is sensitive enough to appreciate that he is not feeling as well as he might, or whether he has had experience enough to know how it feels to be well, is another matter.

Incidentally, possibly the thing that is most needed in the attack on disease is greater appreciation of the significance of the minor degrees of discomfort that may and should be recognized as evidence that something is wrong. The well body should have ease; lack of ease means disease or, at the least, disorder.

The Term Disorder.

Another old English term for sickness was distemper. It survives today only as the name of a virus disease of puppies. Yet the word distemper had much to commend it as a generic term. It is derived from the Latin root *temper*, which implied time and also proportion or distribution. As first used to describe human ills, it implied disorder, which is exactly what disease is—a disorder of either the structural make-up of the body or of the way in which the body behaves as a whole or in some of its parts.

Disorder is the fundamental thing in sickness—a lack of harmony in the workings of the body. This causes more than lack of ease; it causes lack of adequacy or fitness. That is the true meaning of disease.

Webster's Dictionary gives as synonyms of disease *sickness, illness, malady, and ailment;* and as a general definition "a condition in which bodily health is seriously attacked, deranged or impaired" . . . "any departure from the state of health presenting marked symptoms." This definition should be contrasted with that given by Gould's Medical Dictionary, "A disturbance of structure or function of any organ or part of the body." It will be noted that in the latter no reference is made to seriousness, nor to marked symptoms. This accords with the general use of the term by physicians, who know that not all diseases present marked symptoms in the early stages (e.g. cancer), and that some are not serious (e.g. chicken pox).

The term disorder is used as the title of Part III because it appears to have deeper biological significance than the term disease, and also because it is applicable to all departures from normal health, not only to those the public recognizes as frank diseases.

Antiquity of Disease.

In a fossil plant that existed 4½ million years ago, according to geological calculations, disease has been recognized. This early instance of disease was found in a water lily, on which a snail had become a parasite. It seems probable that throughout the ages parasitism has been, as it is now, the commonest cause of disease. There is evidence that man's bacterial parasites established their habits before history began. Archaeologists have unearthed fossil remains of prehistoric creatures showing in their bony structure clear evidence of bone infection, pyorrhea, and decayed teeth. Some of them appear also to have had tumors of bone, and also rheumatism affecting the joints.

The earliest evidence of disease in humans has been gained largely from the examination of Egyptian mummies. It appears that five or six thousand years ago many of the same diseases occurred as now. For example, Marc Ruffer reports cancer, tuberculosis of the spine, pneumonia, kidney stones, and many others that still afflict mankind. Some of the writings of ancient Egypt tell the same story. The Smith Papyrus and the Ebers Papyrus, dating back several thousand years, describe the treatment of many of the same diseases we know today, and, what is more, mention some of the same drugs (e.g. castor oil).

It appears that the human constitution cannot withstand all adverse influences, and that when it becomes disordered it is likely to do so in certain particular ways, much alike in all races and in all times.

The Concept of Disease.

That man from the beginning should have tried to account for disease is only natural. Regarding some diseases, the answer was forthcoming by simple observation. The operation of laws of cause and effect in some cases are fairly obvious. The ancients, for example, were well versed in the toxic, or poisonous, properties of substances with which they came in contact. When they were at a loss to account for a condition on obvious grounds their theory was that the disease was due to a "visitation" of evil spirits within them. For ages man tried to cope with disease on this basis, by efforts to drive out the demons of disease.

In time, the concept arose that all disease—like the broken leg after a fall or the stomach ache after eating unfit food—might be explainable if only one knew enough about what went on in the body. This concept led to research and study on the part of gifted individuals, and to isolated discoveries here and there.

Finally the theory was established that all conditions of the body are the logical result of interaction between the body and its environment and of interaction between the cells and fluids within the body. These interactions, if favorable, give health; and if unfavorable, give disease. All that remained then was to find out precisely what these interactions were—each and all.

The task has been stupendous and is by no means completed. Yet science has found out many of the answers, and in the past 50 years has brought under control many of the diseases against which man had previously been helpless for thousands of years. The key in every case is observation and logical inference regarding cause and effect.

At the present time it is recognized that the body is an adaptive mechanism, able to make adjustments of many kinds to protect itself from harm either from within or without; but that there are certain conditions to which adaptation is difficult, or indeed impossible. When adaptation fails, disease occurs; and it lasts until adaptive power returns, either "of its own accord" or with the aid of medical treatment.

In the process of disease a multitude of factors are usually involved. These may be classed as *extrinsic* (environmental) and *intrinsic* (personal).

Extrinsic Factors.

The world is full of agencies to which man must adapt or be injured by them. These may be classed under three headings; *physical, chemical* and *bacteriological.*

The physical forces of nature itself are potentially hostile to man. Survival for man has been extraordinarily difficult in view of his need not only to adapt to nature but also to make nature serve to his advantage. Sun and wind, fire and frost, heat and cold, flood and tide, electricity and the force of gravity—all have exacted their toll of human lives. To make the situation still more complicated, man has harnessed many of the forces of nature to machines, exerting mechanical energy, electrical energy and the like; and these, his inventions, may release their energy so as to injure him.

The chemical injuring agents, too, are products either of nature or of man's ingenuity. The latter are today by far the more numerous dangers.

The biological agents of disease that most seriously menace man today are the micro-organisms commonly grouped as bacteria. Many of the minute animal organisms, and some of the small creatures such as insects and reptiles, also menace health. A few of the larger animals present dangers (e.g. cattle, subject to tuberculosis from which man may take the disease). In the list belongs man himself who has ever been inclined to hostility toward his own kind.

Intrinsic Factors.

The common belief is that if a disease has no external cause it has no cause at all. That, of course, is not the case. To be sure, many of the diseases to which man is subject are at least partly traceable to one or another factor from the environment, but that is not true of all. A considerable number of trivial ailments and also some of the major diseases are not traceable to any specific environmental factors. Such major diseases as cancer, the degenerative diseases of the heart, blood vessels and kidneys, and diabetes are personal diseases, in the sense that they arise from personal rather than environmental causes. It is these personally caused diseases that now stand highest among the causes of death.

In regard to the diseases that do spring from environmental causes primarily, they too are partly determined by personal causes. Scarcely any disease can be attributed to any single external cause. When disease appears it is often due to a vast concatenation of

interacting factors, many of them within the individual. Even of a bacterial disease such as pneumonia, the cause in a given case is not solely the pneumonia germ, but also the individual's response to its invasion. Many a person exposed to pneumonia does not take the disease.

Similarly, not every person in a given circumstance will become a victim of the force of gravity and fall down, and of those who do, not every one will break his leg. To stumble over an irregularity in the pavement may involve a particular susceptibility to falling, and this may refer back to a defect of equilibrium, or weakness of the muscles, or faulty neuromuscular coordination, or poor vision, or drug intoxication, or preoccupation of the mind, etc., etc. And to break a bone on falling may involve a special susceptibility to fracture, and this may refer back to the diet, the condition of the endocrine glands, etc.

Within a certain range below the level of the inevitably harmful or fatal injuries, the outcome upon exposure to physical, chemical or bacterial injury is an individual matter. What determines the outcome may be an apparently minor difference between one person not harmed and another person seriously harmed by the same agent—for example, a little more pigment in the skin may protect the former from serious harm from too hot sun. Often the difference between two people may be a matter of the entire constitution—every cell in the body being perhaps sounder and more efficient in doing its work in the one who escapes disease. These constitutional differences often are inborn, but also they are often the product of happenings during the lifetime from birth onward. When a sound constitution prevails, it usually implies both good heredity and good nurture. In general, a good constitution is a factor of importance in preventing disease.

There is, however, another side to the story. Many of the dangers man confronts daily are no respecters of constitution. This is true of that juggernaut of physical force, the automobile, or that sinister poisoner, the "lullaby pill." There are no supermen "beyond good and evil" when life is the issue.

Diseases: Hereditary, Congenital and Acquired.

a. Hereditary.—A disease is hereditary if it results from determining factors in the germplasm of which the individual was formed, such factors (genes) having been present in the sex cells of either parent before the two cells united, and having been derived from the ancestral line of either parent or both. At whatever time a hereditary

disease makes its appearance, its origin was before the individual life began as a single cell.

Hereditary diseases are not to be defined as those that "run in families." Usually they do appear in several members of a family, for the reason that each may have received the same determiners; but there are other reasons for familial diseases.

Not many definite diseases are hereditary, but a number of predispositions appear to be so. This subject is more fully discussed in Chapter 44.

b. Congenital.—All diseases that are not hereditary are acquired. Those that are acquired during the period before birth are called congenital.

c. Acquired.—This term is applied to diseases acquired from birth onward. Those that result from causes operating at the time of birth are called natal, and those within a short time afterward are called neonatal. Many of these had their origin during the prenatal period.

Acute, Subacute and Chronic Disease.

According to their duration, diseases may be classified as either (*a*) acute, which come on suddenly and tend to be terminated in one way or another in a few days or at most a few weeks; (*b*) subacute, which may begin gradually, as when an acute disease "hangs on," perhaps for many weeks; (*c*) chronic, which may follow either of the former, but which may have an inconspicuous beginning without an attack of illness of any kind, and which tend to last through life (unless, as is sometimes the case, they are subject to curative treatment).

Some sorts of disease are always acute (e.g. most of the communicable diseases except syphilis and tuberculosis); others are essentially chronic (e.g. "Bright's disease" or chronic inflammation of the kidneys). Many ailments that finally become chronic were not so at the start, and would not have become so unless neglected in the early stages (e.g. chronic middle ear infections).

There is no inherent relationship between duration and severity of disease: some of the shortest are the most serious (e.g. pneumonia), and some of the longest the least serious, at least in regard to length of life (e.g. dandruff, acne). Nor is there any relationship between duration, severity and curability: a disease may be short and sharp, but curable; or long and apparently insignificant, and yet incurable and ultimately fatal.

Lesions of Disease.

The various causes of disease produce defects in body structure called lesions (*laesa*, harm). These may be large enough to be visible to the naked eye, in which case they are called gross lesions. Examples familiar to the layman are the lesions appearing as boils, produced by bacteria; burns, by fire; bruises, by mechanical violence. In the internal organs similar lesions may occur. For example, an abscess not unlike a boil may form in the appendix, or an inflamed area not unlike a burn may form on the membrane lining the stomach.

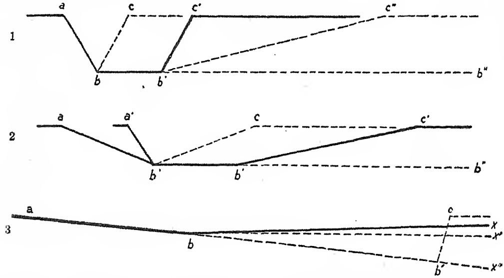


FIG. 42.—Diagram illustrating the course of illness. Lines *ab* indicate varying rapidity of onset. Lines *bb′* indicate varying duration. Lines *bb′b″* indicate possible longer duration after an acute or subacute illness. Points *c*, *c′*, *c″* indicate cure. Points *x*, *x′*, *x″* indicate illness indefinitely prolonged, or chronic. In Fig. 3, line *b′c* suggests the possible interruption of chronic illness by curative treatment.

Lesions often arise not from external causes but from changes starting within cells. In such cases, the lesion for a time at least will affect the microscopic appearance of a tissue more distinctively than its gross appearance. For example, a small swelling may give no gross evidence of its real nature. Therefore, to diagnose a lesion it is sometimes necessary to examine some of the diseased tissue under the microscope.

The types of lesions are of various kinds, and they differ in their seriousness. Some are consistent with good health and do very little harm of any kind (e.g. fatty tumors in the skin, etc.). Others cause discomfort, but are not essentially serious (e.g. corns). Others are serious enough, but curable (e.g. broken bones, pneumonia, etc.). Others are essentially fatal (e.g. hardening of the liver, some types of tumors, etc.).

The differences between lesions depend, first, upon the changes they produce in structure and in function, according to the organ involved and the way it is involved. There are also differences between the different types of lesions in their tendency to repair themselves; their tendency to spread locally or in other ways; their response to treatment; and their preventability.

Types of Lesions.*

Among the more common tissue changes, the following may be mentioned.

1. *Atrophy.*—A shrinkage of cells and tissues from normal development, with accompanying loss of function. Cells may atrophy when the blood supply to them is poor; after long pressure upon them; or after a long period of disuse; or when nerve impulses to them are interrupted (as in the muscles involved in infantile paralysis). Ordinarily atrophy progresses slowly except when nerve impulses are suddenly and completely cut off (as after a nerve has been cut). Atrophy is one of the features of the general deterioration of old age.

2. *Hypertrophy.*—Overdevelopment of a part in size and function, usually with multiplication of cells. Often hypertrophy arises in response to increased demands for work, as in the case of the heart which requires more pumping power when its valves are damaged; and in the case of one kidney when the other is diseased. Such hypertrophy is called compensatory. When hypertrophy is harmful it may be because the increased size of the organ does harm by pressure on other organs, or because the increased function is excessive. For example, hypertrophy of the endocrine glands within the skull might do harm on both counts. A simple form of hypertrophy is that of the epithelium in a corn.

3. *Fibrous Changes.*—Replacement of normal cells of a part by fibrous connective tissue, following local poor nutrition or injury by any cause. The function of an organ is impaired in proportion to the replacement of its active cells by cells having no such function. Fibrous changes are thus called degenerative. Such changes in the heart, blood vessels and kidneys are the chief cause of the high death rate from diseases of these organs. The process of aging involves many fibrous changes throughout the body.

4. *Hyperemia.*—An excess of blood in a part, commonly called congestion. The excess may be due to an abnormal inflow of the blood, or to a reduced outflow. The latter is a common result of "sluggish circulation," and may be chronic, in which case the organ involved may be seriously diseased (e.g. the kidneys).

5. *Anemia.*—Too little blood in a part, either because of decreased inflow, or increased outflow. Fainting is due to anemia of the brain. Often when hyperemia is present in one part, anemia will be present in some other parts. (Note: This use of the term anemia should be distinguished from its use to describe a disorder of the blood itself, involving deficiencies in the red blood cells.)

6. *Fatty Changes.*—Fat deposited in the tissues to excess. (Due to nutritional and other conditions in the body.)

7. *Edematous Changes.*—Fluid deposited in tissues to excess. (Often due to circulatory disorders.)

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* *Some of those not mentioned here are discussed elsewhere.*

8. *Pigmentary Changes.*—Normal pigment of the skin deposited in it to excess, or pigment of the blood or the bile abnormally distributed. (Due to various causes. An example is jaundice, or bile pigment in the skin.)

9. *Calcification.*—Calcium deposited in excess in its normal locations or in abnormal locations (e.g. in cartilages, joints, blood vessel walls), or forming stones in fluids (e.g. in the gall bladder, kidneys, etc.). (Due to chemical and other conditions.)

10. *Failure of Calcification.*—Insufficient deposit of calcium where it should be deposited (e.g. in bones and teeth), as in rickets. (Due to nutritional and endocrine conditions.)

11. *Necrosis.*—Death of tissue. (Due to its actual destruction, as by a burn; or to the failure of its blood supply.) Gangrene is a variety of necrosis. Bacteria may have a part in this condition.

Two important lesions, *inflammation* and *tumors*, are discussed in the next two sections.

Inflammation.

In response to certain injuring agents, tissues become inflamed, and thereby suffer impaired structure and impaired function. An inflamed area always shows *rubor* (redness), *tumor* (swelling), *dolor* (pain, due to pressure of the swollen tissues upon the nerve endings in the area), and *calor* (heat, due to the warmth of the blood in the part). These characteristics of inflammation are due to an excess of blood in the part, as a response to local irritation. The four Latin words date back to Celsus, 100 A.D.

The causes of inflammation are numerous (e.g. insect bites, friction, burns, irritant dust and chemicals, and bacteria). Bacteria are likely to enter any inflamed area sooner or later, and to infect it, whether or not they originally caused the inflammation, because inflamed tissue is particularly non-resistant to bacteria.

Although it is an abnormal condition, inflammation brings with it the possibility of its own cure, for many white blood cells pass out of the engorged vessels and exert both a chemical and a physical effect upon foreign material and destroyed tissue cells (this process is called phagocytosis, which means "devouring"). Also, the fibrin from the blood plasma collects around the inflamed area and walls it off from the sound tissue. The fluid of the blood and of the destroyed tissue together form an exudate (e.g. watery serum in a blister), which may be given off from the area (e.g. the watery nasal discharge in the first stage of a cold).

If the exudate contains many white blood cells, together with bacteria of the pus-producing sort, it is called a purulent exudate, or pus.

Inflammation may occur on any interior or exterior epithelial *surface*. Examples are: bronchitis, inflammation of the membrane

lining the bronchial tubes; and conjunctivitis, inflammation of the membrane around the eyeball. Also, inflammation may occur in organs, involving either the *whole substance* of an organ or a part of it. Examples are: encephalitis, or inflammation of the brain; parotitis (mumps), inflammation of the parotid gland. When the surface involved is the lining of a hollow organ or of a tube or of one of the cavities of the body, the enclosed space may constitute an abscess cavity (e.g. middle ear abscess, or appendix abscess). Any of these inflammatory lesions may be acute, subacute, or chronic.

The elements of danger in inflammation are: (*a*) that the cells of the part will be destroyed beyond the possibility of complete repair; (*b*) that pus, if present, will not be discharged from the body but will spread to other parts nearby and cause infection to extend; (*c*) that bacteria from the part will be taken up into the blood stream or the lymph stream and cause general infection of the body (probably fatal) or infection of important organs, with serious and permanent, if not fatal, results. Inflammation even of the most minute extent is always potentially serious. Even when inflammation is cured, the after-effects may be seriously hampering (e.g. scar tissue; page 94).

In all severe inflammation, there is likely to be a rise of body temperature (fever). Infection should be suspected, even though not evident, whenever fever is present.

Tumors.

The word tumor means swelling. Most swellings are due to inflammation, in which case they are not called tumors. A tumor is an overgrowth of cells of the part. There are two main kinds of tumor. One sort is called benign (kindly) not because it is always entirely harmless, but to distinguish it from the far more serious malignant tumor or cancer.

A benign tumor occasionally may have to be removed for some such reason as pressure on a neighboring part (e.g. fibroid tumor of the uterus) or constriction of a tube (e.g. prostate tumor constricting the urethra). When removed they do not recur. Many of the small benign tumors do no harm in the tissue where they are located, and comparatively seldom become malignant. However, any tumor should have medical inspection occasionally, particularly if it causes any symptoms or undergoes any change.

Cancer is fatal unless it can be destroyed by radium or X-rays or removed by surgery. It consists of an overgrowth of cells of the type characteristic of embryonic life but not normally present after birth.

Embryonic cells, before birth and also in cancers, grow far more rapidly than mature cells. They consume an extraordinary amount of nourishment at the expense of the body as a whole. Therefore the individual with cancer wastes away. Also, toxic products from the abnormal growth gradually undermine health. Other symptoms occur according to the location of the damage.

A cancer tends to invade and destroy neighboring tissue. Some of its cells may detach themselves and spread through the lymph vessels to glands near by, or through the blood vessels to other organs. This transplantation is known as metastasis.

This disease is further discussed in Chapter 12.

Structural and Functional Changes.

Although often microscopic at first, the tendency is for lesions to cause gross anatomical changes, great or little. The whole or a portion of an organ or part may be actually destroyed, or its character changed in some way. For example, solid parts may enlarge or shrink; hollow organs or parts may dilate or contract; tubular structures may narrow or widen; any part may change the regularity of its contour; parts normally united may separate; parts normally separate may adhere; thin tissue may become thick; thick tissue may become thin; smooth tissue may become rough; soft tissue may become dense and hard; firm tissue may become soft; excess tissue may be formed; etc.

With any of these changes of structure, there is some degree of change of function. The essential cells of a part may wholly or partly cease to do their work. Both the physical and the chemical aspects of bodily life may be impaired. Whether the change either of structure or of function is serious depends upon several factors, as suggested in the next section.

Severity of Lesions.

Some lesions are essentially more serious than others. Cancer is always serious. Most lesions, however, even cancer, vary in severity according to (*a*) their location; (*b*) their extent; and (*c*) the stage they have reached before treatment is begun.

a. Location.—Other things being equal, any lesion in the more highly differentiated and important tissues such as the brain, heart, kidneys, lungs, liver, etc., is more seriously handicapping than one involving simpler tissues such as skeletal muscles or skin. Also, any lesion so located as to press upon, or spread to, or to disturb the function of important organs, is more serious than one less critically located. For example, fracture of the skull is potentially more serious

than fracture of an ankle. Furthermore, any lesion within the interior of the body is potentially more serious than one on the exterior, because it may be less readily recognized and less accessible to treatment.

b. Extent.—If the extent of a lesion is great enough to affect a large proportion of any given tissue, regardless of the kind of tissue, its effect will be serious. A burn of the skin, while not ordinarily serious, may be fatal if it involves one-third of the surface. A lesion need not be large to be of great importance physiologically. When there is only a small amount of a given tissue to serve a given purpose, none of it can well be spared. A lesion destroying one kidney, for example, reduces excretory power by half, and the chances of a long life by nearly as much.

c. Stage.—Some lesions of an essentially serious nature are comparatively much less serious in their earlier stages than after they have become well established. Even many forms of cancer are superficial and not at all menacing if given proper treatment early enough. Conversely, some lesions that are not essentially serious may become so if neglected. This is especially true of those lesions that tend to spread, or in other ways to involve other tissue. Decay of teeth, simple when local, may eventually involve the jaw bone and even remote parts of the body. Similarly, neglect may increase the seriousness of conditions that tend to become locally chronic, as is the case with inflammations of nasal membranes and sinuses.

Symptoms and Signs of Disease.

When disease is present it usually manifests itself by *symptoms* and by diagnostic *signs*. A physician finds out what the ailment is—makes a diagnosis—by learning the symptoms of which the patient complains; by taking the history of the illness, and the previous health history of the patient and anything that pertains to it; and by examining the patient for the various signs of disease and for signs of disorder anywhere in the body. To diagnose even a minor ailment a complete physical examination may be necessary. In addition, the physician makes certain laboratory tests if they are necessary, as they usually are.

Symptoms.—The term symptom refers to a *subjective* phenomenon, not necessarily demonstrable as such to any observer (e.g. pain). However, some symptoms give objective evidence as well (e.g. cough).

The feeling of pain is due to sensory nerve impulses from tissue that is changed in some way. There is usually pain from tissue that is inflamed and swollen. Severe pain may arise from swelling within a

confined space, as a joint or root of a tooth. If fluid is confined under tension in a hollow organ, pain arises as a result of tension (e.g. within the appendix) and subsides quickly when the fluid escapes (e.g. rupture of the appendix). Pain also arises at the surface of the body when the protecting layer of epithelium is destroyed and the deeper and more tender tissues are exposed, as in a burn or cold sore.

The layman's efforts to interpret his symptoms often result in some confusion. For example, a symptom may be severe when no serious illness is present (e.g. "stomach ache," or "sick headache"); or may be slight when the body is gravely threatened (e.g. beginning of cancer). Furthermore, symptoms may be located in one part and the real trouble be elsewhere (e.g. nausea when the appendix is inflamed). In such a case, the remote symptom often is a nerve reflex. Finally, the identical symptom may be present as evidence of a minor malady or of a very serious one (e.g. sore throat may be a symptom of an ordinary cold, or of the beginning of scarlet fever).

Symptoms may have a constructive value. For example, when a part is painful (e.g. a sprained joint) it is less likely to be used, and the rest it obtains may help in the cure. Again, a cough may represent the attempt of the respiratory tract to rid itself of excessive secretions, although some coughs arise from dry irritated membranes.

Signs.—Diagnostic signs of disease are essentially *objective* phenomena, demonstrable to those trained to note them. However, in some cases the signs of disease are observable both to physician and to patient (e.g. swelling). Such signs do not usually mean the same thing to laymen as to physicians, however. A sign that means nothing to the patient, although he notes it, may mean a great deal to a physician (e.g. bluish color of the skin; inequality of the pupils of the eyes).

Many signs of disease are not apparent except to those who have had clinical experience in interpreting the evidence of their five senses. Moreover, many signs cannot be recognized, even by physicians, without special instruments of precision (e.g. stethoscope, to intensify the sounds of heart and lungs).

Laboratory tests of numerous sorts are in common use by all physicians. They are frequently done to gain evidence regarding chemical matters in the body (examination of urine, various tests of the blood, etc.). Whenever the presence of bacteria is suspected, specimens of body secretions or excretions will be taken for microscopic examinations. Often it is essential to visualize otherwise invisible outlines of parts of the body by the use of X-rays or the

fluoroscope. Numerous other tests are valuable for special purposes (e.g. the Ascheim-Zondek test for pregnancy.)

Disorders without Lesions.

It is possible for the behavior, or function, of an organ to be disturbed when the organ itself is entirely sound. For example, many people when somewhat frightened—as when called upon suddenly to make a speech in public—will find the heart beating rapidly, the mouth dry, and perhaps the knees weak. In such a case there would be no suspicion that heart disease or any other ailment had come on suddenly, for the exciting emotional cause would be obvious. Clearly, emotion has affected the nerve impulses to the heart, the salivary glands and the skeletal muscles; and the action of all of these parts will return to normal when the disturbing situation is over. The explanation is not so clear when such symptoms arise from less obvious emotions, or from other conditions that interfere with orderly nerve impulses to muscles and glands.

Disorders not demonstrably due to lesions are called *functional*, to distinguish them from *organic* disorders due to lesions. Many, if not the majority of, human ailments are functional, and a large proportion are of the type cited—functional *nervous* disorders.

In the same category are certain *chemical* disorders that do not change the structure of the body, but that do upset functions. Among them are some of the dietary deficiencies. However, when body chemistry is disturbed either by deficiency or excess, lesions are likely to arise ultimately if not at once.

Of a somewhat similar nature are *mechanical* disorders which do not involve any departure from normal structure, but which may finally cause organic damage. Such, for example, is backache due to poor posture.

Functional disorders may be acute, but they are especially likely to be chronic, as a result of continued faulty ways of living. The symptoms they cause may be mild, but they may be as severe as if they sprang from organic disease. They are sometimes difficult to diagnose, since organic disease must first be ruled out, and then the reason for the disturbance of function be discovered. Almost any symptom may indicate in some cases functional disorder with lesions, and in other cases an underlying organic defect. As for prevention and cure, theoretically all functional disorders should be preventable and curable, since they depend chiefly upon habits of living, presumably modifiable.

Classifications of Disease.

In this chapter, diseases have been classified according to their *time of origin*, as hereditary, congenital or acquired; according to their *course*, as acute, subacute or chronic; according to their *cause*, as extrinsic (physical, chemical, bacterial), or as intrinsic; and according to the presence or absence of *lesions*, as organic or functional. All diseases fall somewhere in each of these four groups.

For convenience diseases are often grouped in still other ways. For example, any disease is either *communicable* from the sick person to others, or non-communicable. This is an important difference, in view of efforts that must be made to protect communities from the spread of the communicable diseases. Also, it is often useful to group diseases according to *age predispositions*, as the diseases of infancy, childhood, adult life and old age; or according to *sex prevalence;* or according to incidence in certain *special classes* (e.g. the diseases of maternity, the diseases of certain occupations, industrial or otherwise); or according to *geographical prevalence*, as tropical, high altitude, etc.

Physicians often classify diseases according to the *system* of the body or tissue involved (e.g. nervous, gastro-intestinal, etc.); or *general manifestations* (e.g. febrile, with fever; wasting; degenerative); or *severity* (mild, moderate or severe); or tendency toward *cure* (progressive or stationary, curable or incurable, self-limited or subject to treatment); or methods to be used in *treatment* (medical or surgical, the term medical in this case meaning anything not surgical).

Finally, diseases may be classed as preventable or not preventable. Regarding prevention more will be said in later chapters. It has already been indicated that the medical profession classes many diseases as preventable.

RECOVERY

"Vis Medicatrix Naturae."

This expression, the healing power of nature, is one that is frequently on the lips of discerning physicians. There is reason to believe that in every disease nature makes some "purposive efforts" toward healing. Often these are entirely effective; often, not.

The remedial work of the body may be illustrated by describing what happens when a blood vessel is cut. If it is a large blood vessel and the bleeding point is not pressed upon, nature's efforts are in

vain, but they will have taken place in any case. If the vessel is a smaller one—for example, one in the nose—the bleeding may eventually stop even though for a time it was severe.

When a blood vessel is cut, immediately an extra supply of blood-clotting substances appear in the blood from the liver, to clot the blood at the opening and close it. If much blood has been lost, leaving the total volume of blood in the circulatory system reduced, the blood vessels contract in parts of the body that at the moment do not need much blood (e.g. the muscles and the skin), leaving the full supply available for the heart and the brain. Also, a reserve supply of blood from the spleen enters the blood vessels, together with fluid from tissues. The adrenal gland pours its secretion into the blood to aid in the narrowing of the vessels not needing to be kept full, to stimulate the heart, and to increase the available energy by setting free some of the stored sugar in the liver. The role of the physician in such a case is to know what nature is trying to do, and to work with nature. For example, after a severe hemorrhage a physician may hasten the restoring of the volume of blood by injecting blood or fluid into a vein (transfusion).

Regeneration of Tissue.

The most successful type of healing is that which may occur when cells that have been destroyed are completely replaced by *new cells of the same kind*. This is known as regeneration. In some animals the power of regeneration is amazing. For example, a lobster can grow a whole new claw to take the place of one that is lost. In man such extraordinary power does not exist, but most of man's cells are capable of regeneration to some extent and in some circumstances.

Regeneration of tissue when it occurs is a manifestation of the intrinsic power of cells to multiply, and their tendency to do so to meet the organism's needs. What stimulates them is not known, nor what stops them when repair is complete. The process of regeneration is similar to that of compensatory hypertrophy (page 84).

Certain tissues regenerate well after some types of injury. For example, if a bone is broken and the two ends are close together, they will shortly unite by the formation first of soft bone-forming cells in which later are deposited the minerals that turn them into genuine bone. The role of the physician is that of bringing the ends together and securing them, so that nature can do the rest. He must see that every handicap is removed and nature is free to do its work completely.

In general, young tissue regenerates better than old. A broken bone, or indeed any damage of tissues in the aged, may not be restored to normal. The simpler tissues usually regenerate better than those more highly specialized. Nerve fibers regenerate in some circumstances, but brain tissue does not. On the other hand,

Fig. 43.—Repair of unreduced fracture, showing deposit of bony tissue around both ends of bone. Ten weeks after fracture.

cartilage is a simple tissue, yet it does not repair well; and liver tissue is highly specialized, yet it may regenerate in 6 to 8 weeks as much as 65% of tissue removed by surgery. The difference in this case may be in the blood supply, for tissues well supplied with nutriment through the blood are better equipped for regeneration. However, skin regenerates, but muscle, with equally good blood supply does not, although it repairs well by fibrous tissue.

The body seems entirely helpless in the presence of the riotous growth of embryonic cells of cancer. And against a number of other lesions, the best that can be done by nature is not good enough.

Repair by Fibrous Tissue.

In certain types of lesions the reparative process consists of the growth of fibrous tissue, rather than a regeneration of the proper

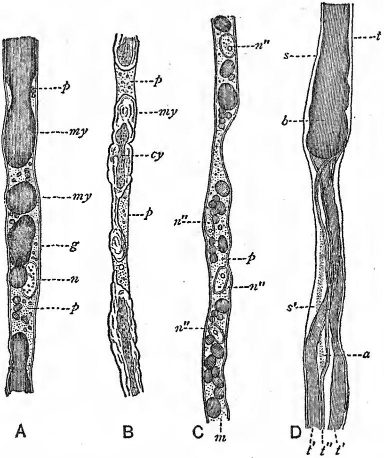

FIG. 44.—Degeneration and regeneration of nerve fiber. A, degeneration of the part of the fiber separated from its cell body. B and C, more advanced stages of degeneration. D, regeneration commencing; the fibers t′ and t″ have sprouted from the cut end of the nerve (b) and are growing toward the severed portion. If not too much scar tissue forms in the gap, the new fibers are likely to reach the degenerated part of the nerve, which may regenerate. (Halliburton "Handbook of Physiology.")

cells of the part. This sort of repair is familiar because of the fact that skin wounds of any extent are likely to be repaired in this way, giving a scar that is obviously unlike the surrounding tissue. Scar formation may occur in the repair of any part of the body. It is firm and strong, and in many respects is structurally satisfactory.

The formation of scar tissue occurs as follows: first the blood vessels in the lower part of the area send out buds that become loops, to nourish the tissue that is to form; then fibrous tissue cells

multiply around them, filling in the damaged area. The scar, of glistening fibrous tissue, is the visible evidence of such repair. In the case of the skin, if the area is not too wide, new epithelial cells may grow over the surface. In wide areas, transplanted bits of epithelium (skin graft) may "take root" and restore the wound to normal. The process of repair by fibrous tissue may take place within organs as well as on surfaces. As is always the case, a "clean" injury, i.e. one not contaminated by bacteria, heals better than an infected one.

Restoration of Function.

Repair by scar tissue often fails to restore *function* entirely. In many parts of the body (e.g. in bone, skin, muscle) a small amount of scar tissue serves very well; but in other areas it may be a poor substitute for the cells that were there before.

First, fibrous cells do not take up the work of the proper cells of a part, and in the actively functioning organs, such as the liver, it does not do to have too many of the cells that should be working replaced by inactive fibrous cells. Even a very small amount of scar tissue is most unfortunate in certain locations (e.g. in the cornea of the eye, where opaque scar tissue does not serve the same purpose as the transparent cornea).

Second, scar tissue has a tendency to contract in all dimensions in time, and it may change the shape and size of hollow organs and cause narrowing or closure of tubes, ducts or openings. Mechanical difficulties caused by scars in themselves often constitute disease (e.g. valvular heart disease consists of scar tissue at one or more of the valves in the heart, which keeps them from opening or from closing completely). Moreover, contraction of scars may eventually lead to disease (e.g. disease of the bladder may result if its outlet is so narrowed that it cannot be completely emptied).

Other Reparative Processes.

The self-righting power of the body is manifest in many other ways than can be mentioned here. Yet in practically no case of illness is it safe to "let nature alone." Although the results might be good, they might not. Nevertheless, one of the strongest reasons for trying to maintain a high level of fitness is that the body shall be unhampered and do its best work in case unavoidable illness does arise.

Chapter 5

INFECTION

The Discovery of Bacteria.

In 1659, Kircher, peering through his hand magnifying glass at objects of one sort and another, discovered that in such materials as soil, milk, cheese, vinegar, blood, and the nose secretions of those who had the disease called plague, and even in the secretions of the well, there were minute specks of material he did not recognize. He thought they were the result of decay.

In 1675, Leeuwenhoeck, an Amsterdam linen merchant, who usually used his hand lens for examining the texture of linen, used it upon a variety of materials obtained from the human body. He described the same small bodies that had been described a few years earlier, and wondered what they were.

Both of these observers noted that these microscopic objects were sometimes present in and on substances that were not of animal origin and in secretions from the well, but that they were most particularly likely to be found in secretions from the ill. It was not until 1762 that it was suspected that these small particles were alive. Plenciz, a Vienna physician, noticed that there were more of them in a specimen on the second day he examined it than on the first. He shrewdly guessed that they must have multiplied. Also, he announced his belief that they were the cause of the diseases they accompanied, and that the spread of these diseases was due to the spread of these small living things from person to person.

Final proof that this was so came as a result of the work of Louis Pasteur and Robert Koch, who in 1876 first linked a disease of humans with a particular sort of microscopic organism. The science of bacteriology began with this discovery. Since then, a world of microscopic living things has been revealed.

Advances in this science came through further improvements in the *compound microscope*, and improved methods of *staining* materials so that bacteria stood out plainly from their surroundings. Also, methods were discovered for the *culture* or growth of bacteria in the laboratory, and thereby it became possible to study all the

life habits of bacteria and to learn the conditions that favor their growth or that destroy them.

Through the science of bacteriology, many of the most serious diseases have been brought under control. Nevertheless, bacteria and the like continue to be the most threatening foes of mankind's well-being. Individuals singly, and the public generally, can do nothing more important for health than to apply to the full the numerous scientific methods now available against them.

Parasites.

It was early discovered that not all bacteria are harmful to man. In fact, many kinds exist only in inanimate objects, and are not only harmless, but indeed in many ways of value, to man. Such, for example, are bacteria responsible for the flavor of cheeses, the "curing" of tobacco, and the fermentation of liquids.

The most valuable of all the bacteria are several varieties that live in the soil and cause chemical changes in decaying plant and animal matter, producing nitrates for the nourishment of growing plants. Without the aid of these bacteria, the cycle of death to life among plants and animals would be incomplete.

The vast majority of bacteria are the sort that can live and multiply in nature outside the bodies of animals and man. The minority cannot. Instead, their preferred abode is the living animal or human body, upon which they become *parasites*, and in which they cause infection.

The term parasite is from the Greek; *para*, beside or near; *sitos*, food. A parasite is an organism that lives on or in the body of another, called the *host*.

As would be expected, parasites may be harmful to their host, by nourishing themselves at his expense, or in other ways affecting his tissues unfavorably. Those that are harmful, actually or potentially, are called *pathogens* (*path*, disease; *gen*, producing). The disease condition that pathogens produce is called *infection*.

That man was subject to infestation by animal parasites visible to the naked eye had been known from time immemorial. Certain diseases had also been related to such infestation. For example, the early Hebrew rules against the use of pork as food were undoubtedly due to the observation that swine are often infested with trichinae, from which man may receive the disease known as trichinosis.

The volume of disease caused by *infestation* with animal parasites is, however, very small in comparison with *infection* by the lower forms of life, the minute invisible parasites called bacteria.

Bacteria.

Bacteria are single cells (of the vegetable kingdom, although popularly known as "bugs"). They carry on their lives much as do the larger plants—that is, they breathe, feed, excrete, and reproduce, but usually have not the power of locomotion. When bacteria thrive in the human body, it is because the body provides favorable conditions of warmth, moisture, food, and oxygen.

FIG. 45.—Various bacteria. (MacNeal.)

In form, a *bacterium* may be spherical, in which case it is called a coccus, with prefixes to indicate the type (e.g. streptococcus, meningococcus, gonococcus, etc.); or rod-shaped, called a bacillus, with an adjective or prefix to differentiate it (e.g. tubercle bacillus, colon bacillus); or spiral, called a spirillum, spirocheta, treponema, etc. (e.g. the treponema pallidum of syphilis).

At first, all the agents of infection were called bacteria, and the science concerned with these minute agents of infection was called bacteriology. It still bears that general name, although other agents of infection besides bacteria have been discovered.

Some of them are larger than bacteria, although still microscopic in size. Among these may be mentioned the *protozoa*, causing such diseases as malaria and amebic dysentery.

Others are smaller than bacteria, and cannot even be seen through the highest powered microscope (i.e. are ultra-microscopic). Among these are the *filterable viruses*, so called because they are so small that they pass through the finest porcelain filters. They cause many of the important diseases, such as infantile paralysis, smallpox, measles and the common cold.

All these agents of infection are known as *pathogenic micro-~~organisms,~~* or living things, microscopic in size, producing disease. For practical purposes, it is permissible for the layman to call the various agents of infection bacteria. That some of them have other technical names is unimportant to the layman in understanding infection and the methods of escaping it. Therefore, in this text the term bacteria is used as an inclusive or generic term for all classes of infecting agents. The terms germs and microbes are in common use in the same sense.

Infection: Local Damage.

When bacteria enter the body and are able to thrive and grow, they may do harm to the tissues both locally at their point of entrance and throughout the body. Harm is due to the fact that bacteria, while carrying on their normal life processes, interact chemically with the tissues upon which they nourish themselves, producing poisons which may do local damage and even be carried throughout the body.

The commonest of the local lesions caused by bacteria is inflammation. It is the typical lesion produced by one large class of bacteria, the pyogens (*pyo*, pus; *gen*, producing). The characteristic feature is a whitish or yellowish exudate known as pus. This is the material formed in the late stage of a cold, in sinus infection, ear infection, pimples, boils, "pink eye," gonorrhea, and a host of

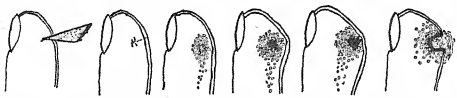

FIG. 46.—Superficial infection from the time of entrance of bacteria-bearing object into the finger, to the discharge of pus.

other infections on the surface or within the body wherever pyogens multiply.

Some bacteria produce other local lesions, and some produce little or no local reaction but proceed at once to the tissues for which they have a special predilection. For example, tubercle bacilli do not produce inflammation either where they enter the body or where they establish themselves, but produce their typical lesion the tubercle after they enter the lungs or other parts of the body. The large class of organisms called viruses do not of themselves produce inflammation, but are often associated in their action with pus-producing organisms (e.g. a cold, due to a virus, may be accompanied by inflammation due to pus-formers).

The Spread of Infection.

Regardless of the local damage done by bacteria, whether much or little, infection may spread from its original site, and do harm elsewhere, either in other separate locations or throughout the body.

There are three main ways whereby infection spreads. First, it may spread by *continuity*—that is, along the tissues adjoining the original site. For example, the sinuses may become infected

by spread from the nasal passages. In some cases, infection spreads along special tissues. For example, the virus of infantile paralysis appears to enter the nasal passages and to spread along the nerves leading from that area to the brain.

Second, infection may enter the *lymph* circulation in the infected area and spread in lymph vessels which themselves become infected (lymphangitis). Because of the phagocytes in the lymph nodes, the infection may be arrested there, but in a virulent infection, these, too, may become infected (e.g. enlarged glands in the neck after a sore throat).

Third, infection may enter the blood vessels in the area and be spread by means of the *blood.* General infective processes carried by the blood are known as *septicemia*, *bacteremia*, or *toxemia*, according as septic (poisonous) material from the infected area, or bacteria themselves, or the toxins of bacteria, are circulated thus in the blood.

Any of these conditions may be of varying degree of severity. The severe blood infection known as "blood poisoning" is septicemia or bacteremia. A severe toxemia accompanies such diseases as diphtheria and tetanus. A mild toxemia often accompanies even a well localized infection such as a boil or a cold, causing such symptoms as fever, and a feeling of sickness, with lack of energy, lack of appetite, headache, etc. It is probable that a considerable number of people never feel quite as well as they should because of minor degrees of toxemia from local chronic infection.

In the case of any of these spreading infections, remote organs may be injured. For example, pus germs travelling in the blood may set up similar pus infections elsewhere (e.g. on the valves of the heart, from infection in the throat). Similarly, the toxins from a local area may do specific damage to the tissues to which they are carried (e.g. nerve tissue, in the case of several of the toxin-producing bacteria), or they may sensitize and harm almost any tissue.

The Names of Infections.

Some bacteria always cause typical lesions in particular tissues, and give the same symptoms, the whole constituting a disease entity with a special name (e.g. measles, mumps, etc.). These infections are transmissible from person to person as such. These are discussed in Chapter 7.

Other bacteria cause typical lesions, but not necessarily in any one part of the body. In such a case, the infection may be named according to the particular organism (e.g. streptococcus infection).

Infection is often named according to the part of the body involved, with the suffix *-itis* to indicate inflammation (e.g. appendicitis, laryngitis, etc.), the name not indicating anything about the causative organism.

Except for the specific diseases, when an infection is transmitted from one person to another it does not necessarily take the same form in the second person as in the first. However, when given germs are transmitted from person to person, they always cause their specific lesions. For example, the pyogenic organisms transmitted from a boil in one person to the eyes of another would cause a pus infection there. Similarly, a streptococcus infection in one person gives rise to a streptococcus infection in a second person although not necessarily in the same location as in the first.

Virulence of Infection.

Infection is not the inevitable result when bacteria are taken into the body. Whether infection occurs or not, depends primarily upon the virulence of the bacteria, or their readiness to produce disease.

Virulence varies among the various kinds of bacteria. Some are always virulent; some seldom; others vary. The virulence of bacteria does not necessarily correspond with the severity of the disease they cause. For example, the virus of chicken pox is always virulent, but the disease it causes is mild.

Another factor that determines the outcome when bacteria are received is individual resistance, a matter to be discussed in the next chapter.

Acute and Chronic Infection.

Infections may be acute, subacute, or chronic, according to the time they last. An acute infection when severe usually means that a large number of bacteria, of high virulence, have entered a non-resistant tissue. The outcome may be serious unless aid is immediately forthcoming, either from the tissues themselves or from medical treatment. In any case, the body either wins or loses its fight promptly. Acute infections are short, but mild or severe, as the case may be.

When the body wins in an acute infection, health may be almost, but not quite restored. A few bacteria may remain to cause a low grade of trouble a little longer. This is called subacute infection. With proper care, it usually subsides in a few weeks.

A chronic infection is one that persists. It may begin and continue as an inconspicuous sort of infection that causes few symptoms (e.g. tuberculosis); or it may begin acutely, but never entirely

subside (e.g. a sharp attack of appendicitis settling down to be a "grumbling" appendix).

The difference between these types of activity, again, may be due to a difference in virulence of organisms or in resistance of tissues.

Resident Bacteria.

This term may be used to describe the bacteria that are normally found on the skin, in the openings of the body (such as the nose, mouth, and throat) and in the intestinal tract. Although born without them, everyone acquires them early in life.

They may never cause harm, but they are potentially a danger. First, they may be aroused to activity by a change in the local conditions which favors their growth. For example, the throat bacteria may grow and multiply and cause infection after the throat membranes have been altered as a result of chilling or of irritation. Similarly, the skin bacteria may cause infection if the skin is wounded. For example, a cut allows the skin bacteria to obtain better nourishment from the blood and also allows them to go deeper into tissues not so resistant to them as the skin.

Second, resident bacteria transplanted outside their usual zone may find the new location more favorable for them, and may start infection there. For example, intestinal bacteria (chiefly colon bacilli), if they migrate to the appendix or the gall-bladder are quite likely to infect these organs.

A Focus of Infection.

A part of the body that is itself infected and from which infection has spread to other parts of the body is called a focus of infection. The term is particularly applicable when the remote harm of the infection is more important than its local harm. This may be the case with chronic infections that are inconspicuous and give little or no trouble (as, for example, chronic infected tonsils or teeth), but from which serious trouble arises elsewhere (as in the joints, the heart, etc.).

In order to place the blame for illness on a focus of infection, it must be demonstrated that the part actually is infected. Doctors do not remove normal tonsils or teeth merely on suspicion that they are causing trouble. On the other hand, one of the main advantages of a thorough physical examination is that any genuine focus of infection, not only in the tonsils and teeth, but anywhere in the body, may be cured before it has undermined health.

Sources of Infection.

For the most part, human infections come from other *humans* who are infected. A person who is a source of infection may be either sick or well. If he is sick, he may be only slightly so, or severely so; and he may be either at the beginning, or at the end, or in any stage of the illness. If he is well, he may have recently recovered from the disease; or may have had it long ago; or, so far as he knows, may never have had it.

The sick person as a source of infection is known as a *case;* the well person as a *carrier.* In some respects, as can be seen, the well carrier or the nearly well case, is potentially a source of more danger than the person who is frankly sick and therefore more likely not to be associating with others.

Man is capable of "taking" some few of the diseases of *animals* (e.g. rabies from dogs; tuberculosis from cattle, etc.). The principles of infection are the same as from human to human.

Transfer of Infection.

A. Routes.—Bacteria from the interior of the body *leave* the sick person or the carrier by the various secretions or discharges (for example, "cold" germs leave through the nose and mouth; typhoid germs through the urine and excreta); or from the surface, when it is itself infected, or when it has become contaminated with germs from within the sick person's body.

Bacteria *enter* the body by any of its natural openings or through the skin. It is estimated that 95% of all infections enter through the mouth.

B. Means.—Transfer takes place by means of *contact,* either *direct* or *indirect,* between the infected person and others. Each of these modes of transfer will be separately discussed.

Direct Contact.

The most certain way by which bacteria can be transferred is by some sort of direct contact between the infected person and another (e.g. kissing, handshaking, etc.).

An almost equally direct transfer of germs from the nose and mouth is through droplets of saliva that pass from one person to another, as in sneezing, coughing and forcible talking, or when merely breathing directly toward another's face. These droplets will contain germs in all cases of infection of the respiratory tract, or of any disease in which germs are given off through the nose and mouth. This semi-direct contact is of great importance.

Indirect Contact.

Indirect contact implies an intervening object or creature between the infected person and others. Inanimate objects transmitting infection are known as *vehicles* of infection. Such objects while bearing bacteria are known as contaminated or infected. Living creatures that transmit infection from one infected person or animal to another are known as *vectors*. Strictly speaking, a vector is a passive agent, not itself infected.

Vehicles.

A. Water.—Before the era of public water purification and sewage disposal, much illness (e.g. cholera, typhoid fever) was caused through contamination of water with bacteria from the intestinal tract of humans. In this country cholera is no longer a menace, although the New York City department of health was established less than 75 years ago to combat it. The disease still rages in many Oriental countries. Typhoid fever persisted longer in this country than cholera, but it is now practically non-existent in the large cities.

Private water supplies are not so often safe-guarded as public supplies. Bacteria from excreta placed on the ground may reach the underground source of a well or a spring. River and lake water may be infected by sewage turned into it. A considerable proportion of cases of typhoid now occur among campers in the woods, who do not take proper precautions about boiling the water from any uncertain source. Not only may typhoid germs be acquired thus, but also several other sorts of bacteria that infect the intestinal tract, and some of the intestinal worms.

B. Milk.—Bacteria may not merely live in milk but may actually multiply in it. Since milk is an important food for young and old, it is particularly important to protect it.

The source of bacteria in milk is either infected cows, or infected humans who handle milk anywhere from the dairy to the home, or from contaminated material that enters milk during the various stages between its production and its consumption.

Among the diseases that may be spread by means of this vehicle are: tuberculosis (either from a cow or a human), typhoid fever, septic sore throat, diphtheria, scarlet fever, and undulant fever.

To insure the safety of a milk supply, the first step is to make sure that it comes only from well cows, and is handled only by well people, in a clean dairy. These matters are governed by local regulation and inspection. In 1939 the United States Public Health

Service reported that 874 cities had adopted its recommended uniform milk ordinance, but that only 148 cities required all milk distributors to show safe milk ratings.

Because the safety of a public milk supply cannot be completely ensured even by the most rigid control, pasteurization of milk is, and always will be, necessary. This process was devised by Pasteur, for the purification of wines. It consists of keeping milk at 145° F. for 30 minutes.

A final important requirement is that milk be promptly cooled, and kept below 50° F. until it is used. This, and in fact, all other precautions regarding milk, are as applicable in the home as elsewhere.

C. Food.—Any food sold outside the state in which it is produced is subject to the laws of interstate commerce, and its production is subject to Federal inspection. Even the purest foods may, however, be contaminated after they are placed on sale or reach the home, if handled by infected persons, exposed to dust or insects, not kept properly refrigerated, or not sufficiently cooked. There is danger especially with food that is to be eaten uncooked. Both in public places and in homes, it is probable that bacteria of many diseases are frequently transferred by food. Epidemics of intestinal diseases in particular are often traced to an infected food.

D. Soil.—Harmful bacteria of several sorts are deposited in the soil in the excreta of man or animals (e.g. the tetanus bacillus, which lives as an inert spore in the soil). As a rule, these organisms enter the body through the skin, especially through a wound which admits soil.

E. Fomites.—This term is applied to articles used or handled by an infected person. Among them may be mentioned: toilet articles; bathroom fittings; doorknobs; eating utensils; bed clothing; personal clothing, including handkerchiefs and gloves; personal belongings, such as pencils and books; and any furniture, furnishings and fixtures upon which bacteria could fall or be deposited. In the case of dry objects, there is little danger unless the interval is short between its handling by the sick person and its re-handling by another. Moist objects may remain infected longer than dry.

F. Air.—The air is important as a vehicle of infection in the immediate vicinity of a person who is expelling bacteria from the nose and mouth. Ordinarily bacteria in the air do not travel beyond the range of droplets, but they may be wafted farther on particles

of dust, which act as floaters for them, keeping them suspended in the air, and ready to be breathed in by others. In a single gram of house dust, as many as 2,100,000 bacteria have been found.

Vectors.

Among the animal vectors, the gnawing animals, the *rodents* (rats, mice, etc.) are the most important. They carry bacteria on and in their bodies. In most parts of this country, the chief danger of these domestic pests is contamination of food with bac-

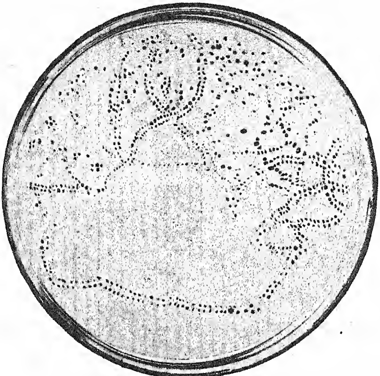

Fig. 47.—Colonies of bacteria which grew on an agar plate after an insect had walked over it.

teria from their excreta. Several of the intestinal infections are thought to be frequently transmitted thus. Some of the more serious diseases, fortunately rare in this country, are transmitted through parasitic insects (lice, fleas, ticks, etc.) that infest rodents and other animals, and may also infest man.

The chief specific insect-borne disease in this country is malaria, transmitted by the female anopheles mosquito. The organisms are taken into the body of the mosquito in the act of biting an infected person, and are given off again by the same method.

Other insects, however, are of considerable importance because of the variety and number of bacteria they may carry on their surfaces or in their digestive tract. The diseases they carry depend

upon the bacteria to which they have access. The domestic fly is one of the worst offenders. Recently 415 flies were examined for bacteria, and it was found that they averaged a million and a quarter on the surface and from sixteen to eighteen million in the intestines. Flies are important vehicles for the distribution of intestinal infections if they have access first to excreta (as in privies) and later to food.

Indirect infection through any of the routes mentioned may be roundabout, involving several classes of vehicles and vectors. Some bacteria do not live long enough to be transported far from their original source, but many will survive a long journey.

Death of Bacteria.

Like all living things, bacteria die if their environment is unfavorable—that is, if it does not afford suitable nutriment and if conditions of warmth, moisture and oxygen supply are not correct. In general, the bacteria that are parasites on man and animals do not live long apart from living bodies. Most of them die quickly as a result of drying. However, they may survive in water, and are likely to thrive and multiply in moist substances that afford ample nutriment (e.g. milk, food, animal and human discharges).

Some bacteria dry but do not die. They may live years in an inactive state, ready to resume their usual mode of life if transferred to better conditions. The tubercle bacillus, for example, is resistant to drying. Some organisms assume a different form (spore form) under unfavorable conditions (e.g. tetanus bacilli live as spores in the soil).

Although bacteria pathogenic to man prefer the temperature of the human body, many are able to survive lower temperatures, even freezing (e.g. typhoid bacilli may survive in ice).

The effect of direct sunlight is lethal, but since ultraviolet rays do not penetrate substances, they destroy only such bacteria as are on surfaces.

Disinfection.

A. Outside the Body.—To destroy bacteria outside the body, the chief agents are heat, chemicals, and ultraviolet rays. Heat is applied by burning, baking, boiling, or steaming, preferably with the steam under pressure. Each of these methods has an important role in disinfection. The latter is widely used in laboratories, hospitals and food manufacturing plants.

Among the chemicals of high germicial power are corrosive sublimate (bichloride of mercury), chloride of lime; alcohol; car-

of dust, which act as floaters for them, keeping them suspended in the air, and ready to be breathed in by others. In a single gram of house dust, as many as 2,100,000 bacteria have been found.

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The effect of direct sunlight is lethal, but since ultraviolet rays do not penetrate substances, they destroy only such bacteria as are on surfaces.

Disinfection.

A. Outside the Body.—To destroy bacteria outside the body, the chief agents are heat, chemicals, and ultraviolet rays. Heat is applied by burning, baking, boiling, or steaming, preferably with the steam under pressure. Each of these methods has an important role in disinfection. The latter is widely used in laboratories, hospitals and food manufacturing plants.

Among the chemicals of high germicial power are corrosive sublimate (bichloride of mercury), chloride of lime; alcohol; car-

bolic acid and several of its derivatives, such as lysol; etc. The choice of disinfectant depends, naturally, upon the article or substance to be disinfected. Information regarding disinfectants may be obtained from local boards of health, and from the United States Department of Agriculture. Most disinfectants are poisons that must be handled with care.

Ultraviolet rays are useful for the disinfection of surfaces, of the atmosphere, and of water. (See Chapter 33.)

B. Within the Body.—For disinfection of wounds of the skin, tincture of iodine is the most satisfactory, because it is most effective against bacteria and least injurious to tissue resistance.

Mucous surfaces of the body, being more sensitive than the skin, are less easily disinfected. It is not recommended that the layman attempt any such disinfection. Even the use of antiseptic solutions (i.e. those that check bacterial growth, but do not kill bacteria) are not to be used without medical advice.

Bacteria *within the substance of the tissues* or in the blood may in some cases be destroyed by chemicals. Examples are the organisms of malaria (by quinine, etc.), and of syphilis (by arsenic, bismuth, and mercury). For the treatment of many diseases, chemicals are available which either weaken the power of the invading germs, or help the body to overcome them. Among the most important of these are sulfanilamide and sulfapyridine. These two drugs are used against bacteria of several kinds, with excellent results. However, it remains true that any chemicals that will kill bacteria may do harm to tissues, and on that account, these two powerful drugs should never be used except as prescribed by physicians.

Prevention of Infection.

For individuals and communities, countless opportunities are open for preventing infection. With the idea in mind that bacteria are transferred—that is, they go *from* somewhere *to* somewhere else—efforts may be directed toward destroying them (*a*) at their source; or (*b*) at some stage of their journey short of their arrival in a new host; or (*c*) at the end of their journey as they are about to pass the portals of entry into the body.

By suitable *public health* methods, many bacteria may be destroyed at their source or enroute to man (e.g. pasteurization of milk; drainage of mosquito-breeding swamps; isolation of humans infected with communicable diseases; etc.).

By suitable *personal* measures, the portals of entry may be kept closed to bacteria. In general and specifically, some of the important points may be itemized as follows:

1. Avoid direct contact with those who are infected.
2. Avoid receiving droplets from the infected.
3. Avoid contact with germ-bearing secretions or excretions.
4. Avoid touching objects recently touched, or objects in any way soiled by, the infected.
5. Avoid using toilet articles, or any other easily contaminated articles, in common with those who are ill.
6. Avoid soda fountains where glasses are not washed in scalding water.
7. Avoid exchanging clothing with others.
8. Keep the hands clean, in so far as possible, but keep the hands away from unnecessary contact with the skin or the body openings.
9. Avoid touching food with the hands unless the hands have just been thoroughly washed.
10. Avoid infected water, milk and food.
11. Keep everything out of the mouth that does not belong there.
12. Keep the skin whole and clean, and have injuries of the skin promptly treated.
13. Keep the living quarters free from dust and dirt, insects, rats and mice and vermin.
14. Consider pet animals as possible sources of infection, and handle them accordingly.

As the reader will note, at least ten of these measures to prevent taking infection also state or suggest ways of preventing the giving of one's own infection to others.

Chapter 6

RESISTANCE

In comparison with the chances of infection, actual cases of infection are few. And from the infections that do occur, most people recover. Every person of the 130,000,000 now living in the United States must have been exposed to infection day in and day out through life, and must indeed have become infected many times to greater or lesser degree, yet they are all still living. It is evident that the human body must have remarkable powers of defense against its parasitic foes. It is the exception rather than the rule when bacteria win in the combat with man. Yet the battle goes on, and will go on; and it behooves man to become acquainted with the forces at his disposal for strengthening his defense.

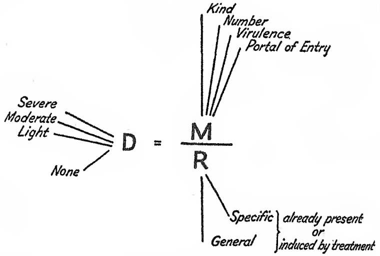

FIG. 48.—Diagram to show that D, disease, is the product of M, microbial attack, divided by R, resistance.

Outcome of Infection.

When a person is exposed to infection, or takes an infection, the outcome may be no disease at all, severe disease and death, or any degree of disease between these two extremes. What happens in a particular case depends upon the ratio between the disease-producing power of the germs and the disease-resisting power of his body. This ratio may be expressed by the formula Fig. 48. In this formula M stands for the microbial attack; and R, for the resistance of the

individual; and D, for disease. Obviously, D will be zero or a minus quantity, i.e. no disease will occur, if R is greater than M.

There are various ways in which the microbial factor can be reduced, as has been indicated in the previous section. Also, fortunately, there are various ways in which the resistance factor may be increased.

Kinds of Resistance.

Resistance is of two main sorts. First, there is the *general* type of resistance which is popularly thought of as virtually synonymous with health. It is that to which people refer when they speak of certain measures of hygiene as aiding in building up resistance. Second, there is a type of resistance which is *specific* against a given type of germ—as for example, resistance to measles after having had the disease.

In either case, resistance may be of any degree, from slight to complete. Complete resistance is called immunity. The opposite of resistance is susceptibility. Naturally, this varies in inverse proportion to resistance.

The Nature of Resistance.

To account for resistance, reference must be made to the white blood cells (page 66). Also, it will be necessary to present another system of the body, not mentioned in Chapter 3—the *reticulo-endothelial* system. It is believed that this system gives tissue resistance in general and produces the substances present in the blood in immunity.

The reticulo-endothelial system has no organs that are exclusively for the checking of infection. In fact it has no organs belonging exclusively to it. It is a system of cells, rather than of organs, the cells being widely distributed throughout the body. They are called histiocytes (*histio*, tissue; *cyte*, cell).

All the cells of the reticulo-endothelial system are *phagogytic* (devouring) cells. They ingest particles such as bacteria and cell debris, much as do the neutrophilic white cells of the blood. They are called *macrophages* (large phagocytes), although they are no larger than some of the white blood cells.

Some of the macrophages are fixed cells, remaining where they are found, as for example, lining the capillaries in the spleen, the liver, the bone marrow, the suprarenal glands, the thymus gland, and lymphoid tissue. Others are wandering cells, such as the clasmatocytes of the connective tissue, which some authorities think

are the most important of all, and the mononuclear cells of the blood and the spleen.

The chief phagocytic blood cells are produced in red bone marrow, and are in constant circulation in the blood. Some of the macrophages also regularly circulate in the blood, for example the white corpuscles known as monocytes; and others may do so upon occasion.

The cells of the reticulo-endothelial system together with the leucocytes are our chief means of defense against bacteria. Some believe that the macrophages are of even greater importance than the leucocytes. All have as a major function the process of phagocytosis.

Phagocytosis.

Whenever any foreign substance such as bacteria enter the body, there occurs at that area an immediate "mobilization" of phagocytic cells from the blood. They are drawn to the area by chemotaxis (chemical attraction) from the injured area. To reach there, they push their way directly through the walls of the capillaries by diapedesis (passing through), as shown in Fig. 49.

The arrival of the phagocytic cells means that a chemical combat begins between them and the bacteria. The leucocytes take the center of the field and the monocytes mass themselves around the borders, where they "wall off" the infected area, to keep the infection within a narrow range if possible.

The bacteria have in their favor the toxins they produce, which are injurious to tissue cells and to phagocytes. Also they have an extraordinary ability to multiply rapidly. The phagocytic cells have in their favor their ability to engulf and digest bacteria. The leucocytes also produce a protein-digesting enzyme (protease).

If enough phagocytic cells are available, in proportion to the bacteria, the "devouring" process may take place without any conspicuous local signs except mild inflammation. But if the bacteria are many and destructive, and many phagocytes are required to overcome them, there may appear on the infected surface or in the infected tissue a semi-fluid substance called pus. This consists of bacteria, living and dead, blood serum, a few red blood cells, and the tissue cells and the leucocytes destroyed by the bacteria.

This exudate will be discharged from the body if it is produced on a surface. For example, the material given off from the nose during the late stage of a cold is nasal mucus mixed with pus produced as a result of bacteria-phagocyte activity. If pus is pro-

duced beneath a surface, as in a boil or carbuncle, the chemical and physical activity in the area tends to destroy the tissue above it, which causes the pus to be discharged. If pus does not become discharged promptly, often it is necessary that an opening be made for its release from the body.

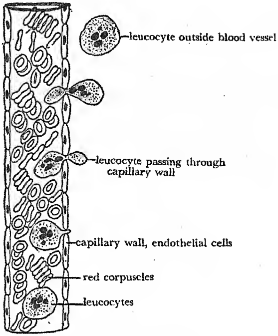

FIG. 49.—Diapedesis.

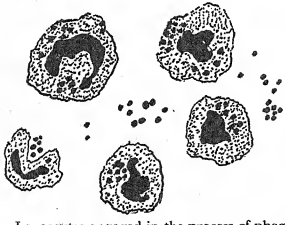

FIG. 50.—Leucocytes engaged in the process of phagocytosis.

Throughout the process just described, the fixed reticulo-endothelial cells of the part are also performing the function of phagocytosis. In time, either the bacteria or the phagocytes win. If the bacteria win, they enter the blood stream, and the battle continues there, with phagocytes still doing their best to devour and destroy the bacteria.

Phagocytic activity is apparently the main means of defense against the class of germs that are called pyogens (pus-producers) because pus is produced during their phagocytosis. These are the germs that commonly enter the skin in wounds, and that may cause blood-poisoning. They are also the germs that are implicated in many colds and sore throats, in appendicitis, and, in fact, are the sole cause of many inflammations.

Immunity.

If the local phagocytic attack on infection is successful, the body as a whole may make no very marked response to the bacterial invasion. However, in the case of some bacteria, the local attack against them amounts to nothing, and the bacteria or their toxins immediately enter the blood and may be carried to remote tissues.

In such a case, the entire reticulo-endothelial system and perhaps all the body cells, may be chemically sensitized so as to produce new chemical substances destructive to invading bacteria or toxins. In other words, the body may render itself immune.

Bacteria when affecting body cells thus are called antigens (*gen*, generating; *anti*, against). The substances produced by the body cells are called antibodies ("bodies" that are "against" or antagonistic to bacteria or their toxins). The term "body" is not to be interpreted literally. It denotes merely that these substances have chemical identity, not that they are bodies in the ordinary sense of the word.

Antibodies begin to appear in the blood plasma within 6–8 days after infection begins. They enter into chemical union with the bacterial antigen that stimulated their formation. This has two beneficial effects. First, the antigen is thereby kept from combining with tissue cells; and second, its toxic properties are "neutralised."

As a result of the antigen-antibody reaction, bacteria agglutinate (clump) in the blood. Then a non-immune substance in the blood (called alexin or complement) dissolves or disintegrates the bacteria in a process called lysis. Also, another substance (opsonin) in blood serum acts upon bacteria in such a way that phagocytic cells attack them much more avidly. The term opsonin means "I cater for." The term and the concept are useful in describing what happens in infection, for some product of the antigen-antibody reaction clearly makes bacteria more "appetizing" to phagocytes. The opsonic power of blood serum can be measured. A high opsonic index signifies a potentially greater power to destroy bacteria by phagocytosis.

It will be noted that four factors have been mentioned as having a part in recovery from a specific infection; the action of specific immune bodies, of non-immune complement, of opsonins, and of phagocytic cells. A fifth important factor is cellular immunity, which begins as soon as antibodies begin to be formed, and which prevents any remaining bacterial toxins from hurting the tissues.

Cell Immunity.

It appears that after an antigen has provoked body cells to a response from which antibodies result, the cells cease to produce antibodies but in the future are insusceptible to that organism. They are in such a state that the same germs make no impression upon them, i.e. are not pathogenic to them. Although the plasma of the blood may remain immune after infection, it seems that the skin and various other tissues become still more immune than the blood. Extracts of many organs have been shown to have bactericidal action (e.g. liver, spleen, bone marrow, pancreas, thymus, lymph glands, muscle, etc.).

The presence or absence of this immunity of tissue cells is of great importance in resistance to infection and in recovery from infection.

Antitoxin.

Some bacteria do not themselves enter the blood but pour their toxins into it. Such toxins are antigens and excite antibody formation, the antibodies in this case being known as antitoxin. The antigen-antibody reaction occurs as usual, but there are no bacteria in the blood to require lysis and phagocytosis afterward.

Since the toxin enters the blood all ready prepared to act upon cells, the progress of the disease is likely to be extremely rapid, and death may occur before enough antitoxin can be made available. This is the case, for example, with the toxins of diphtheria and tetanus.

Bacteriophage.

The term bacteriophage means "bacteria eaters." This term was given to certain ultramicroscopic substances in the blood, first described by Twort in 1915.

Their nature has not yet been determined, but whatever they may be they have a destructive effect upon bacteria, causing their disintegration or lysis. That this actually happens has been demonstrated by clinical and laboratory methods. They have been described as parasites of parasites. Some believe that they are filterable

viruses; others, that they are non-living substances, perhaps enzymes liberated when bacteria disintegrate; and others, that they may be a transitional form of bacteria themselves.

There are several kinds of bacteriophage, each specific against one sort of bacteria. Some of them have been used in the treatment of certain diseases. D'Herelle of Yale first put them to practical use. In some cases they are highly useful. For example, on the surfaces of the body, as in boils and carbuncles, the staphlococcus bacteriophage often is an aid to treatment. For infections in the bloodstream and the tissues, their use has not as yet been so successful.

Precise conclusions regarding the nature of bacteriophage and its activity in protecting against infection await further study.

Specific Immunities.

The germs to which one may become immune are for the most part those that cause specific diseases. The term specific applies to the germ, the disease, and the immunity.

Such immunity is often (*a*) *inborn;* is often (*b*) *acquired* as a result of having the disease in question; and may be (*c*) *developed artificially* against certain diseases.

Any specific immunity may be either *absolute* or *relative*, and it may be *temporary* or *permanent*.

Inborn immunity comes about in one of two ways. Either the body tissues are by nature insusceptible to a given infection, or they are temporarily so for a time after birth as a result of antibodies received from the mother's blood during prenatal life.

An example of the former is the racial resistance of the Jewish people as a whole to the disease tuberculosis and of the Chinese people to scarlet fever. A still more striking example is the absolute immunity of humans to many of the diseases of animals, and vice versa.

An example of an inborn immunity of a temporary nature is the immunity to diphtheria that exists in most newborn babies. This comes from antibodies in the mother's blood, which may be present even though the mother never had the disease. They are accounted for in the mother on the ground that she had been exposed to the germs to an extent to excite antibodies even though not to give her the disease. The infant's immunity wears off after a few months.

Acquired Immunity.

Acquired immunity comes about as already described, in response to invasion by bacteria. Among the diseases to which a person is likely to become immune after an attack and to remain

so for some time, if not permanently, may be mentioned the following:

chicken pox	Rocky Mountain spotted fever
diphtheria	scarlet fever
German measles	smallpox
infantile paralysis	tularemia
measles	typhoid fever
meningitis	typhus fever
mumps	whooping cough
paratyphoid fever	yellow fever
psittacosis	

It is probable that many adults who have never had the "children's diseases" have nevertheless been made at least partly immune to them by frequent exposure insufficient to make them ill (i.e. "subclinical infection). This may be the case regarding some other infections. For one reason or another, not all people who have not had the disease seem to be equally susceptible to the following:

diphtheria	scarlet fever
encephalitis	tuberculosis
infantile paralysis	typhoid fever
influenza	undulant fever
meningitis	Vincent's infection

However, it is not at all safe to count upon any immunity unless it can be proved to exist (as, for example, by the Schick test for diphtheria, or the Dick test for scarlet fever).

Against some specific diseases, little or no immunity follows an attack. It is to be assumed that antibody production and changes in tissues are barely enough to bring about recovery, but not enough to cause any continued state of immunity. Such is the case with the following diseases:

colds	pneumonia
conjunctivitis	rheumatic fever
erysipelas	septic sore throat
gonorrhea	syphilis
hookworm	tetanus
influenza	trachoma
malaria	trichinosis
tuberculosis	

Artificially Acquired Immunity.

Acquired immunity may also be produced artificially against some of the diseases, by means of *biochemical* substances produced in laboratories. The prefix *bio* (life) indicates that these substances are produced from living things. All such substances are classed as

biological products. They may be introduced into the body by inoculation, to produce artificial immunity, which is either active or passive.

Artificial Immunity: Active.

By the use of antigens developed in laboratories, and injected into the body, the process of antibody formation may be stimulated in just the same way as by bacteria. Antigens used for this purpose are called *vaccines*. The individual who has produced his own antibodies as a result of stimulation by a vaccine is as fully protected as if he had developed them as a result of germs themselves. His state is the same as that of a person who has had the disease and survived. His immunity is acquired, and it is an active immunity in which his own tissues have exhibited their unwitting skill as "chemical manufacturers" of antibodies.

Vaccines are available to prevent several diseases. The outstanding example is *smallpox* vaccine. Another of equal importance is toxoid used to prevent *diphtheria*.

In this class also belongs the *rabies* vaccine, which is a preventive treatment even though not given until after exposure. Its preventive effect is due to the fact that the disease rabies develops more slowly than the active immunity against it.

In 1939, Zinsser announced that he had succeeded in producing a vaccine that could be produced in a large scale for the prevention of typhus fever of the European type, a lice borne disease that is a serious menace to armies. This discovery has been described as "more important than the invention of a new anti-aircraft gun."

Other effective vaccines are those for typhoid fever, paratyphoid fever, whooping cough, scarlet fever, tetanus, secondary infections of the common cold, yellow fever, cholera, plague, tularemia, and undulant fever.

No process of active immunization is effective after a disease has begun. Passive immunization is the method when disease is present.

Artificial Immunity: Passive.

After antibodies against a given disease have appeared in the blood serum, the *serum* (containing the antibodies) may be used to convey ready-made antibodies to another. Immunity produced in this way is called passive because the individual who receives it has not been active in producing it but has merely received it passively.

If received promptly enough, antibodies from outside sources together with those the individual himself is making may check the illness or modify its severity.

Blood serum from humans who have recently had the disease (convalescent serum) is often used. So also is the whole blood of those who may not have had the disease, yet whose blood furnishes what is necessary to aid immunity. In some cases, the extract of a particular organ, the placenta, provides the required antibodies.

Most of the serums are produced in laboratory animals. The animal is given antigen to stimulate its antibody formation, and the serum is then prepared for use in humans who are infected and need more antibodies than they are able to make for themselves.

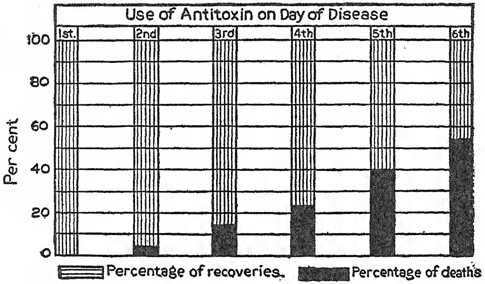

Fig. 51.—(From Moore, "Public Health in the United States," Published by Harper & Bros. Prepared by Schereschewsky on data of Kolle and Hetsch.)

Among the most important serums are the antitoxins for diphtheria and for tetanus, and the serums for pneumonia and meningitis. Others are the serums for undulant fever, tularemia, cholera, and plague; and the antitoxins for botulism, scarlet fever, erysipelas, and gas gangrene.

In some cases a serum may be used for prophylactic purposes if given after exposure to a disease but before illness begins; it may prevent the disease from appearing or modify its severity. This is the case with measles, for example.

Serum is not effective against some diseases such as infantile paralysis; the tissues over which the virus passes to enter the nerve tissue, and the nerve tissue itself, are not given resistance by antibodies, but must develop it, if at all, within themselves. That they often do so, is shown by the fact that comparatively few people fall victims to this disease.

It has already been mentioned that pre-formed toxins from bacteria may affect susceptible tissue very early in the infection.

a feeble person, and to die of it unless he has antitoxin promptly. Similarly, a well person bitten by a rabid dog is as likely to have rabies and to die of it unless he begins the Pasteur prophylactic treatment at once. General resistance, obviously, should be supplemented by specific resistance whenever that is available.

Several factors have been found to be of particular importance in keeping the body cells able to do their work of repelling and overcoming infection. In laboratory animals both the circulation and diet make a difference in the reaction to infection.

A. Circulation.—Experiments have been done by Arthur Locke, using warming time as a test of circulation, followed by inoculation with germs to test resistance. Warming time means the number of minutes it took the experimental animals to regain a temperature of 98° F. after it had been reduced to 95° F. The animals warmed up slowly when their circulation was impaired. The same animals proved to be less resistant to Type I pneumococci than the animals that warmed up more rapidly. Locke says the experiments suggest that "at least one of the factors in increased resistance of physically well persons to infection lies in the capacity to maintain improved circulation."

B. Mineral Salts in the Diet.—It has been shown by Church that general resistance may be altered by the amount of minerals in the diet. In mice, when the level of minerals was lowered to one-fourth of that normally present in their good diet for two weeks before they were inoculated with germs, the fatality rate was raised from 9% to 34%. Also, when the calcium in the diet was reduced from 0.55% to 0.10%, the fatality rate increased from 12% to 59%. The conclusion was that a diet insufficient either in total mineral salts or unbalanced in respect to mineral salts decreased resistance.

C. Vitamins in the Diet.—In general, the effect of vitamins is toward the normalization of tissues, and it would be expected that this should have a beneficial effect in promoting resistance.

Vitamin A has long been known to protect the normal condition of the skin and the mucous membranes. At one time it was called the anti-infective vitamin. It is now known that it does not have a specifically preventive or curative effect against colds or any other infection, except as it tends to keep tissues normal—and in the presence of virulent germs and viruses that might not amount to much protection. An additional amount of vitamin A in an already satisfactory diet would do nothing whatever to add further to the

health of these tissues. However, for resistance against infections of the skin and the respiratory tract, the intake of vitamin A should be adequate. When vitamin A intake is low, infections of the upper respiratory tract and skin, and also of the sinuses and ears, occur more frequently.

A. M. Yudkin reports that in pronounced vitamin A deficiency "As the disease progresses, intercurrent infections of the skin, lungs and urinary tract may occur, and finally the condition may terminate as a bronchopneumonia or a diarrheal disorder."

Bloch and Spence showed a high incidence of skin infections among infants and children with symptoms of vitamin A deficiency. Mackay reported the prevalence of boils, sores, impetigo and other evidence of skin sepsis in children with vitamin A deficiency.

Vitamin C may be of importance in resistance to infection, according to its discoverer, Szent-Gyorgyi. He has stated that a deficiency of vitamin C "may be sufficient to throw the balance in favor of infections . . . in patients with low resistance." A guinea pig may be protected from diphtheria by the administration of vitamin C, or made more susceptible to diphtheria by a diet low in this vitamin. A protective effect of vitamin C against tuberculosis has been repeatedly shown. It is also known that it inhibits the growth of streptococci in test tubes. Like all the vitamins, it has a normalizing effect on many tissues.

D. Protein in the Diet.—Being the foundation substance of which cells are made, protein would be expected to aid cells in whatever work they have to do. It may be of particular importance when there is infection to be overcome. Meyers, of Johns Hopkins University, fed rats on a diet rich in casein (milk protein) for 17 to 21 days before inoculating them with diphtheria and found that they had much higher resistance than rats fed on a diet high in carbohydrates and fats.

Factors Unfavorable to Resistance.

Poor circulation and inadequate diet—the opposite of the factors just mentioned—are two among many factors that have been noted as having a prejudicial effect on resistance to infection. Among others may be mentioned:

(1) Alcohol. Aside from its effect on nerve tissue, its most important effect appears to be that of decreasing resistance to infection, particularly to pneumonia. The dog, naturally immune to tetanus, can be given the disease after a dose of alcohol.

(2) Decrease of alkali reserves in the body. The protective substances in the blood appear to be less effective in a medium less alkaline than normal blood serum. The acids of fatigue may be a hindrance when present in excess, and so also may other acid end products of metabolism.

(3) Adverse temperature changes, as in chilling of the whole body, or local chilling of one part, with congestion elsewhere. The hen, naturally immune to anthrax, can be given the disease after it has stood with its feet in cold water long enough to become chilled. This classical example of the effect of chilling appears to be amply confirmed in the experience of humans. It is not so often recognized that exposure to extreme heat may have a similar effect. Summer infections of the intestinal tract in infants appear to be at least partly due to lowering of resistance by hot weather.

(4) Changed chemical conditions as a result of disease. For example, an excess of sugar in the blood predisposes to infections of the skin and in some other locations.

(5) Loss of blood, or anemia from other causes, with the attendant poor nutrition of cells.

(6) Fatigue. After doing an amount of work that produces marked fatigue, an animal may often be given an infection to which it would ordinarily be resistant. This may be due partly to excess acids in the blood, and partly to cell depletion, and decreased phagocytic activity of leucocytes.

(7) Other infection already present in the body. The mechanism of defense may already be taxed or in other ways hindered from making an adequate response to a new infection. Many fatal illnesses are due to a superimposed or secondary infection which by itself might have been resisted. This is true either of existing acute infections or of chronic ones.

(8) Convalescence. After an acute illness the body may perform none of its functions, including that of resisting infection, in its normal manner. If the disease from which convalescence is taking place was an infection, a re-infection of the same sort may appear, or another infection.

(9) Chronic constitutional disease, especially when it reduces muscular activity and slows the circulation, or when it involves certain chemical changes or tissue abnormalities.

(10) Intestinal stasis. There appears to be some evidence that constipation may be a factor in leading to infections of the appendix and the gall bladder, and possibly it may lower the general resist-

ance. Many dermatologists find a correlation between constipation and the skin infections of the disease acne.

(11) Defective function of the endocrine glands. It has been shown that resistance to infection may be lowered when the secretion of the cortex of the adrenal gland or of the thyroid gland is reduced in amount. Conversely, there may be increased resistance in those who produce an excess of these secretions.

(12) Immaturity. Culbertson of Columbia confirms the accepted opinion that maturity brings a greater degree of resistance. Experimentally he found that young laboratory animals showed less efficiency on the part of the monocytes and the leucocytes and also that they mobilized specific antibodies less well than older animals. "Natural maturation" he states "enables older animals to combat illness more effectively than younger ones."

Medical Treatment to Aid Resistance.

In many infections on the surface of the body, treatment by disinfectants is important, but the chemical must not be so strong as to interfere with phagocytic activity.

Within the body a few drugs will kill specific germs. But for the most part, what drugs do is to help the body's own forces of resistance. This, for example, is the case with the drug sulfapyridine when used against such a disease as pneumonia. The individual's specific antibodies do not begin to appear in the blood until after the drug plus the type-specific serum has cured him. It appears that the drug inhibits the growth of the organisms, that the antibodies in the immune serum unite with them, and that the phagocytes do the rest. The individual's own antibody production, as soon as it begins, is also of importance in the prevention of relapse during convalescence.

Often the medical treatment during an infection aids resistance indirectly rather than directly, by providing support for the heart, or aiding in elimination of the waste products of metabolism, by promoting rest and sleep, or in other ways enabling the body to put forth its best efforts.

Chapter 7

THE SPECIFIC COMMUNICABLE DISEASES

Definition.

A disease is called communicable or transmissible (or infectious or "contagious") if it spreads from person to person, the second person having the same disease as the first. A communicable disease has the following characteristics:

(1) It is always due to the same specific kind of microorganism.

(2) It always produces similar lesions and symptoms, although of varying extent and severity.

(3) It is always acquired from another person (or animal) that had the same disease, the transfer being either direct or indirect.

(4) It may spread so widely as to cause an epidemic ("upon the people").

(5) It may be so "catching" that it is acquired early in life (for which reason some of the communicable diseases are called "children's diseases").

(6) It may arouse immunity in persons who have it, thereby preventing a second attack.

(7) It may be preventable by artificial immunization. (Theoretically, this is a possibility with all the communicable diseases; practically, this is so regarding many, but not all.)

(8) Its control in a community comes under the police power vested in official health boards.

Clinical Course of a Communicable Disease.

The student is referred to the diagram, Fig. 53, as an illustration of the time element in the course of communicable illnesses.

(*a*) *Incubation Period.*—For each disease there is an interval after the germs enter the body before the signs and symptoms of the disease appear. During this time the germs are multiplying. In the case of some few infections (e.g. those due to pus germs), the germs begin their activity at once, and there is either no incubation period or a very short one.

Diseases are ordinarily not communicable to others during the whole of the incubation period (although there are exceptions,

notably gonorrhea). But toward the end of that time, often several days before the person realizes he is ill, he may give off even more germs than during the more active stages of the disease. This fact adds immeasurably to the difficulties of preventing the spread of infection.

(*b*) *Duration of Active Disease.*—The communicable diseases are inclined to run a short, sharp course, and to end in one way or

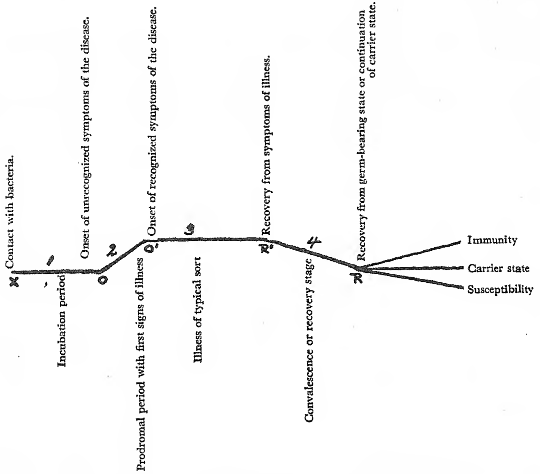

FIG. 53.—Diagram to show the course of a communicable disease. Note that susceptibility may be the same as before, or may be increased.

another in a few weeks at most. Among the exceptions are syphilis and tuberculosis, which may last for years.

During the illness some or all of the typical symptoms appear. There are "light" cases, sometimes even so light that they are not recognized; and severe cases in which not only all the symptoms of the disease itself appear, but others due to complications.

There is usually fever at the onset, and often throughout the disease. As long as fever lasts, and sometimes for other reasons, it is necessary that the patient remain in bed.

Medical attention is always needed. Although the communicable diseases (many of them) tend to cure themselves, they cause thousands of deaths annually which might have been prevented if there had been medical attention to assist nature in its curative efforts.

(*c*) *Convalescence.*—A communicable disease that has run its course ceases to be communicable in most cases. Sometimes, however, the bacteria are still present and virulent for others. When the infective period outlasts the sickness, the patient must continue to be isolated or must use other methods to avoid infecting others. Ordinarily this carrier state does not persist long, but it may do so in diphtheria, typhoid fever, and a few other diseases.

Susceptibility to other infections is often increased during convalescence. Presumably this is due to the fact that a person is more easily fatigued after illness, and also may have a subnormal temperature, which predisposes to chilling, or a disorder of the vasomotor apparatus which causes undue perspiration upon slight exertion and predisposes to chilling if evaporation is too rapid. It is therefore well for a convalescent person to use care about over-fatigue and exposure, and to take a particularly nourishing diet, in order to regain full vigor promptly.

Complications.

Complications are due either to an unusually wide spread of the disease through the body, with involvement of important organs, or to secondary infection (i.e. the invasion of the body by still another sort of germs, such as the pus-formers). Although complications are more likely to arise in severe cases, they may also arise in light cases that seem so trivial that they are neglected.

Examples of serious complications are: heart disease, kidney disease, and deafness, all of which may follow scarlet fever; pneumonia and tuberculosis, either of which may follow measles or even ordinary colds if neglected; infection of the sex glands, which may be a part of the disease mumps, and may cause sterility.

Epidemiological Control.

The control of communicable diseases has been made possible through the development of the science of epidemiology.

Regarding any given disease, the epidemiologist seeks to know the following:

1. *Distribution* of the organism in nature (soil, water, animals, etc.).

2. *Mode of access* to humans (direct contact, specific vehicles such as milk, food, etc.; specific vectors, such as mosquitoes, etc.).

3. *Mode of entrance into the human body* (nose, mouth, skin, etc.).

4. *Distribution in the body* (lungs, intestines, throat, etc.).

5. *Survival in the body* (self-limitation of infection, susceptibility to therapeutic methods, persistence of carrier state, etc.).

6. *Mode of exit* from the body (specific secretions and excretions).

7. *Viability outside the body*, or ability to withstand temperature, drying, light, etc.; spore formation; conditions or media that are specially favorable or unfavorable.

8. *Destruction outside the body* by germicidal methods (e.g. heat, as in the pasteurization of milk; filtration and chlorine, as in purification of water).

9. *Destruction within the body* by methods of treatment (e.g. antitoxin in the case of diphtheria; arsenic in the case of syphilis).

10. *Intermediate hosts*, between original source and man.

It is not absolutely essential that epidemiology be acquainted with the germ itself, provided that it knows enough about how the germ lives and is transmitted. For example, yellow fever was stamped out before its organism was known, by the use of epidemiological knowledge regarding its transmission by mosquitoes. In general, epidemiology is supplemented by facts from the sciences of bacteriology and immunology, and from clinical medicine; and the more of such facts are available, the more likely are its methods to succeed.

On the other hand, having all the data necessary to control a disease, epidemiology may still be unable to control it because of personal factors that enter into the situation and that are not subject to complete control by official agencies. Such is the case, for example, with the venereal diseases, and to a considerable extent with many others.

The methods of epidemiology as they apply to individuals consist largely of regulations governing behavior when ill with a communicable disease, or when exposed to such illness. It takes only one case to start an epidemic if that case is not properly managed so as to protect the group. (See Fig. 54.) That case, and all those exposed to infection from that case, must be recognized and dealt with according to epidemiological principles. Therefore, strict regulations have been made, and are enforced regarding (*a*) reporting of cases of communicable disease; (*b*) observation or

quarantine of contacts, i.e. those who have been exposed; and (*c*) isolation of the sick.

Reporting of Communicable Diseases.

Those in attendance upon a case of communicable disease are required by law to report it to the local board of health, which in turn reports to State offices. Several of the reportable or notifiable

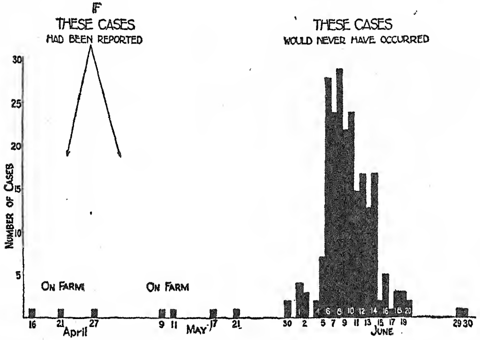

FIG. 54.—The story of an epidemic of septic sore throat. Hundreds of cases occurred as the result of the first cases that were not reported and not isolated. (From Overton & Denno, "The Health Officer."—Courtesy of W. B. Saunders Company, Publishers.)

diseases are listed and commented upon in Section B of this chapter, and others elsewhere.

In groups living in close association, as in colleges, the spread of a communicable disease might be rapid if extra precautions were not taken to recognize the first case at the earliest possible moment. Therefore rules usually require the reporting of *any* illness, whether the individual believes it communicable or not. In some diseases, the earliest symptoms are not such as would be recognized by the layman as typical of a communicable disease, yet are readily recognizable by a physician (e.g. Koplik's spots in the mouth, which appear before the rash in measles).

Several communicable diseases give symptoms at the start that suggest a cold of the nose, throat or chest. Among them are the following:

Diphtheria	Poliomyelitis
Encephalitis	Psittacosis
Influenza	Scarlet fever
Measles	Septic sore throat
Meningitis	Tuberculosis
Pneumonia	Whooping cough

Also, many colleges have rules requiring students to report when they have been exposed to a communicable disease, whether or not they consider themselves immune to it. If the physician determines that the patient is not immune various procedures may be adopted to be of assistance to the exposed individual and to protect the group. Even if not required to do so by group regulations, an individual who has been exposed to a communicable disease should report the fact to his physician immediately. In respect to some diseases, prompt treatment by serum may either prevent the disease from appearing, or cause the attack to be less severe. For the protection of the group, non-immune exposed persons may have to be kept under observation or put into quarantine.

Observation.

Responsible adults who have been exposed to a disease to which they are not immune often need not be put under quarantine, but may be allowed their liberty under certain conditions. During the days when they might be expected to show symptoms of the disease, they must report once or twice a day to the physician for observation, in order that they may be isolated at the moment the very first signs appear.

The time when an exposed individual is likely to show symptoms of the disease is estimated by adding the shortest incubation time of the disease to the date of the earliest exposure, and the longest incubation time to the date of the most recent exposure. For example, if a person were exposed daily from May 1 to May 5, and the incubation period of the disease were 7–14 days, he might be expected to become ill as early as 7 days after May 1, and as late as 14 days after May 5, i.e. from May 8 to May 19.

Isolation and Quarantine.

Isolation is the rule for many, but not for all, of the communicable diseases. The term literally connotes keeping the *sick* person by himself. It of course permits of nursing care, preferably by a trained nurse who knows how to avoid exposing herself unduly or taking the disease to others outside the sickroom. Isolation permits of no visitors. Even those who are themselves immune might carry

the germs to others, unless they are trained, as nurses and physicians are, in the technique of keeping or rendering themselves free of contamination. Isolation from household pets (cats and dogs, in whose fur disease germs might be carried to others outside the sick-room) is also required.

Isolation should begin at the earliest evidence of disease, and must continue until the individual is no longer giving off virulent germs. When the disease is light and the person does not need to be housed, the Board of Health will sometimes permit the patient to go out of doors, provided he does not go near others (perhaps not within 8 feet of others). The duration of isolation, and all matters pertaining to it, are subject to rules of state and local health departments, with any additional rules a given institution may make for its own members.

Quarantine means the restriction of the liberty of *well* people who have been exposed and therefore may shortly have the disease, or who might transfer the disease from their associates who are ill. Those in a household where there is a case of communicable disease are sometimes placed in quarantine, i.e. are not permitted to be at large, lest they carry disease abroad. Adults are usually not deprived of their liberty if they are immune and thus not likely to "come down" with the disease themselves, if they do not take care of the sick person nor go near him, and if their work is not that of handling food nor associating with children.

Disinfection.

a. After Exposure.—In the case of diseases transferred by droplets, the germs ordinarily pass directly to the nose and mouth during exposure. Nevertheless, for the reason that germs may be lingering on the body or the clothing, and may constitute a further danger to himself or to others, it is recommended that an exposed person try to free himself and his clothing of germs as soon as possible. He should wash hands, face and hair, and use a mild mouth wash and gargle (to aid mechanically in washing bacteria away, not to kill them). Also, clothing that has been exposed should be wrapped up by itself, and as soon as convenient should be properly treated (i.e. washed and ironed, or dry cleaned, or sunned and aired outdoors for at least a day).

b. Concurrent.—In former times much stress was placed on final disinfection after a case of communicable disease, and little stress on disinfection from day to day, concurrent disinfection. The latter is now known to be the more important.

The principle of concurrent disinfection is that all infective secretions and excretions discharged from the patient should be destroyed at once, and that articles contaminated by such discharges should not leave the room of the sick person or at least should be disinfected practically at the moment they leave it, or in some way be prevented from contact with others until free of germs.

Some of the details of concurrent disinfection, applicable in many communicable diseases, including colds, are: using paper handkerchiefs and burning them; using one's own set of eating utensils and boiling them before others use them; keeping one's towels, soap and toilet articles apart from those of other people; and touching other people's belongings as little as possible.

Neglect of concurrent disinfection often leads to infection of a whole household. When a cold or other communicable disease "runs through" a family, it may have been due to such neglect.

c. Terminal.—Boards of health give detailed instructions regarding the care of the premises after a case of communicable disease, and their orders must be followed. Fumigation is seldom ordered after the common bacterial diseases, because the germicidal virtues of fumes are less than those of sun and air, and soap and water. In most cases a room will be safe if it is left with the doors closed and the windows open for several days, and is then given a thorough "housecleaning."

Terminal disinfection of the sick person upon recovery is equally important. It includes a soap and water bath, a shampoo, and the use of clothing that has not been in the sickroom, or that has been thoroughly washed or dry cleaned since then.

B. NOTIFIABLE DISEASES

In most of the states and cities of the United States forty-three communicable diseases are notifiable to boards of health. Fifteen other communicable diseases or infestations occur in this country but are not everywhere notifiable; in the list below, these are indicated by a star. Several other diseases not communicable from person to person are of interest to health officers since they involve the food supply, and are potentially preventable; these are mentioned in other locations.

*** "Athlete's Foot."**
(See Ringworm.)

Chicken Pox.

Usually this is a mild disease, with slight fever and a rash. It is due to a filterable virus. The incubation period is 2–3 weeks. The vesicles appear in crops for

three or four days, cause itching, and gradually dry up, forming scabs that fall off. Infection of the skin may occur as a result of scratching. Occasionally a fatal pus infection arises from this cause. Other complications are rare, but may occur in adults. The disease is communicable before the rash appears (from vesicles in the mouth which rupture as soon as they form) until 6–10 days after the first appearance of the last crop of vesicles. The virus is present in the vesicles. Transfer is by direct contact or by articles freshly soiled by nose and mouth secretions and skin. The disease occurs chiefly in those under 15. In those over 15, smallpox should be suspected until ruled out. Chicken pox was first differentiated from smallpox in 1553.

Cholera.

This disease has been called the father of modern preventive medical work of the public type, just as tuberculosis is the father of the personal type. It was this disease which most seriously threatened the United States in the 19th century. Most of our large city departments of health were organized to combat it. Coming from its home in the delta of the Ganges, it made its first appearance in Europe in 1830, and from there it spread to America. In Hamburg, Germany, in 1892, and Lawrence, Massachusetts, about the same time, the first modern water filtration plants were built to combat this infection, which had been recognized as water-borne. The organisms are given off from the sick in the excreta, and reach the well largely through the water supply. Wherever water and sewage are properly cared for, cholera no longer exists. For those travelling in countries still having cholera, active immunization of a year's duration may be obtained by the use of vaccines.

***Common Cold.**

(See Chapter 27.)

Conjunctivitis, of the New Born.

(See Gonorrhea, p. 137.)

Diphtheria.

The term diphtheria is from the Greek, meaning membrane. The disease is characterized by a fibrinous exudate (membrane) on the tonsils, the lining tissues of the throat, nose, larynx, or elsewhere, and by symptoms due to this membrane and to the absorbed toxins of the bacilli. The toxin may affect heart, kidneys, and nerves, in the latter case causing paralyses. Unless these conditions are fatal, they recover completely. Diagnosis of diphtheria is by inspection, confirmed by culture of bacteria in secretions swabbed from infected areas. The treatment is by antitoxin, first produced by von Behring in 1891. Before that time, 45% of cases terminated fatally. Success of treatment is in inverse ratio to the duration of the disease, as shown in Fig. 51.

Diphtheria germs are given off from the ill in the secretions from the nose and throat and any other diphtheretic discharges. Most cases are acquired through droplets from the ill or from carriers. In some epidemics, milk or milk products infected by a case or a carrier have been the vehicle of infection. The incubation period is 2 to 5 days, or longer. Often the disease is present as a sore throat for several days before it is recognized. It is communicable from its first appearance until the secretions or lesions no longer contain virulent bacilli, usually 2–4 weeks after the onset. Isolation is required until negative cultures are obtained. The

patient or others in the household may become carriers. One who carries virulent bacilli must be isolated. Most carriers can be cured.

Prevention of diphtheria is by toxoid. All infants should be immunized as soon as inborn immunity has disappeared. The fatality rate is highest in children under 5 years of age. In France, diphtheria immunization is required by law. In this country, many cities have succeeded in having a large proportion of pre-school and school children voluntarily immunized.

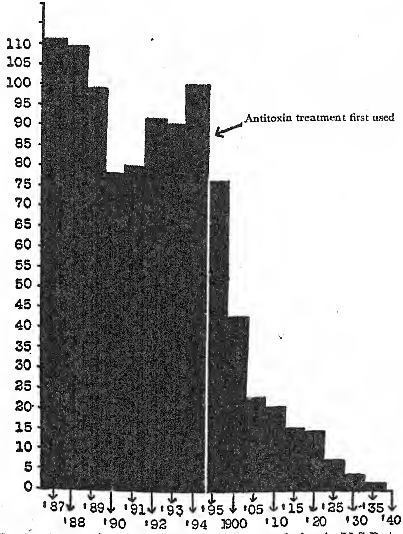

FIG. 55.—The death rate of diphtheria per 100,000 population in U.S.R.A. 1887–1940. Note the marked reduction since the introduction of antitoxin.

Immunity is determined by the Schick test. A positive test is shown by a characteristic redness at the site of the test, which indicates susceptibility. A negative test is shown by absence of skin reaction, which indicates immunity. After immunization procedures, the Schick test is repeated to confirm results.

In 1937 twenty large cities had not a single death from diphtheria. One of these had a perfect record for four years, and another for three years. Although the incidence, fatality rate and mortality rate of diphtheria has been greatly reduced in the past thirty years, it is the result of modern immunization procedures rather than of any change in the disease. It is still potentially as serious a disease as in the past times when it caused overwhelming epidemics.

Dysentery.

A disease characterized by diarrhea, with mucus and blood in the stools. It may be mild or severe. Two types occur: (*a*) amebic; and (*b*) bacillary.

(*a*) *Amebic Dysentery.*—Due to a single cell animal parasite, transmitted by water or food contaminated by infected persons or carriers, or by articles contaminated with their excreta, especially during the stage of convalescence. Although it has long been common in wars, the first epidemic in a civil community did not occur until 1933. It arose in a large city hotel where 11 carriers were found among 364 food handlers. Cross connections between sewage and water pipes were also suspected as a source of water contamination.

The incubation period is 2 days to several months. In some cases, those who acquire the parasites do not have the disease, but become carriers. It is communicable from any of those who harbor the parasites, whether ill or not.

The disease is widespread in the temperate zone, although not common. Often if not properly treated it becomes more or less chronic, giving various intestinal symptoms. Each such case being a danger, examination for these parasites is part of the routine in any prolonged diarrheal disease. If treated thoroughly, the disease is usually curable.

Prevention of amebic dysentery is by the same measures as are used against all diseases transmitted from the intestinal tract: proper disposal of excreta, purification of water; pasteurization of milk, control of food handlers; and protection of food from flies, especially in districts where flies may have had access to intestinal excreta.

(*b*) *Bacillary Dysentery.*—This disease is due to various bacilli all of which were first isolated between 1898 and 1916. It has always been a common epidemic disease in wars. Rosenau says that dysentery bacilli have killed more soldiers than bullets. In civil life, it has been particularly a menace to children under 2. In times past, it was one of the major causes of the high infant death rate. Even at the present time, this disease should be suspected in all diarrheal attacks in infants as well as in adults. Contributing factors are poor health, fatigue, an intestinal tract already irritated by poor food, exposure to chilling, and hot weather.

The disease is not common in epidemic form where sewage disposal, water supply and milk pasteurization are up to standard, although it occasionally occurs in epidemics due to food contamination. However transmitted, the source of the germs is always the intestinal tract, and their entrance is always by the mouth.

Although the disease is self-limited, and the fatality rate ordinarily not more than 2%, as many as one in three of those who have a severe infection may die of it. Also, the disease may become chronic. If recovery occurs, ulcers may remain for some time, although this is not common in well treated cases. The dysentery bacilli are frequently the cause of "summer complaint," or of the diarrhea that comes on holiday trips and is usually attributed merely to "change of water." The prevention is the same as that mentioned for amebic dysentery.

Encephalitis.

This term means inflammation of the brain. The disease is popularly known as "sleeping sickness" because of the lethargic or stuporous condition which is often present. There are several varieties of encephalitis: first, there are two separate types of the disease each due to a specific but different virus; second, there are various forms of non-specific inflammation of the brain such as may follow several acute communicable diseases such as measles, smallpox, or even chicken pox.

Type A Encephalitis.—This is the disease first called encephalitis lethargica. It first became important in this country in 1918. The case fatality is high (20–30%). It is more common in adults than in children. The symptoms vary widely according to the part of the brain involved. Also, the disease varies in severity. Apparently many people are immune to it. If recovery takes place, it may be incomplete, with changes in mind and personality. The mode of transfer is not clear, for which reason its prevention involves all the known ways of protection against infection. Cases are rarely traced to previous cases. In this respect encephalitis resembles poliomyelitis.

Type B Encephalitis.—This type is commonly called equine, because the disease is also a disease of horses. It is a comparatively new disease among horses, and still newer among humans. The first epidemic of it occurred in the St. Louis area in 1933. It returned there in 1937 and the following year in Massachusetts. In the 1937 epidemic, it caused the death of 88,000 horses in the west.

It is thought that an insect vector, probably the mosquito, carries the disease from horse to horse and also to man. Wild birds and also domestic fowl are subject to the disease. A vaccine has been developed which will prevent the disease in horses, and also in humans, but the disease is so rare among humans that its use is hardly warranted except in those who are to be particularly exposed.

Encephalitis following the other communicable diseases is usually a complication only in severe or untreated cases. Its prevention is by preventing the diseases with which it is associated.

German Measles.

A mild disease somewhat resembling both measles and scarlet fever. It is not a form of measles; an attack of one disease does not protect against the other. Besides the rash, the chief symptom is enlarged lymph nodes behind the ears and in the neck. The first symptoms are those of a cold, for a day or two before the rash appears. The disease is communicable at that time and until the rash is gone, usually 4–7 days. Transfer is by contact with nose or mouth secretions, or articles freshly soiled by them. Complications are few, and recovery is usual.

Gonorrhea.

This disease is even more prevalent than syphilis, and in the aggregate perhaps causes almost as much serious trouble. Because it is so prevalent and can do so much harm, it is considered one of the major public health problems. For the individual, gonorrhea always merits the best available medical attention.

The disease is due to a germ of the pus-producing variety. It is acquired largely through sex relationships. Accidental infection through contaminated articles, though possible, is very rare. The incubation period is 1–8 days. There is no such thing as immunity to the disease.

The first symptoms of gonorrhea are itching and burning of the urethra, with pain on urination, and usually frequent urination. Shortly a discharge appears, which may be watery at first, but soon becomes thick and whitish or yellowish. In the female, the discharge may be slight. Any such discharge, in male or female, should receive medical attention.

After a time the discharge may cease, even if untreated, but the germs continue to live in the interior parts. The infection is likely to involve all the genital organs—in the male, the testes and the prostate gland especially; and in the female, the uterus and oviducts. When this occurs, abscesses may form. Many local complications lead to the need for surgical operations, either at the time or later. One of

the common results of gonorrhea in either sex is sterility due to stricture (closing) of the ducts that carry the sex cells.

From its original site, the disease may spread either by the blood or the lymph to remote structures. It may cause a general infection—"blood poisoning"—or infection of joints, giving acute or chronic arthritis, or infection of the heart valves. If the germs are carried on the hands, towels, etc. to the eyes, blindness may result.

Gonorrhea is not transmitted to the infant in the uterus, but during birth the germs may be swept into the infant's eyes as it passes through an infected birth canal. The law requires the use of medicine in the eyes of every new-born baby, whether or not infection of the mother is suspected. This measure has greatly reduced conjunctivitis of the new-born, which was formerly a common cause of blindness.

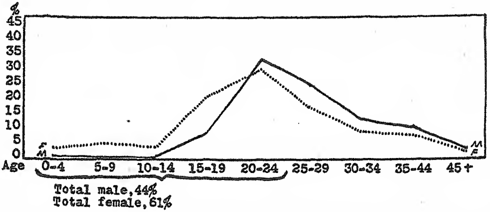

FIG. 56.—Chart showing ages at which gonorrheal infection occurs. (Data from the Massachusetts Department of Public Health.)

The diagnosis of gonorrhea is made by finding gonococci in the discharge. Conversely, cure is gauged by no longer finding them. It requires special skill, however, to be certain that none lurk in any part of the genital tract or elsewhere. As long as a single germ is being given off, the disease may be transferred to others.

Treatment for gonorrhea should be begun at the earliest possible moment, before the disease has spread. At such a time, the possibility of recovery is very good, especially in the male. Several methods of treatment are in use, according to the judgment of the physician in a particular case. The public having been informed of the frequent success of sulfanilamide in curing gonorrhea, it should also be informed that self-treatment by this drug is not safe. In the first place, the drug itself is not suitable for use by laymen; and in the second place, the layman who uses it has no way of knowing whether the infection has really been cured. Many such self-treated cases are still actively infected, not because too little of the drug was taken, but because other, or additional, treatment was needed for the case in question. After any form of self-medication, the individual is likely to remain chronically infected—a danger to himself and to others.

Hookworm Disease.

A disease due to parasitic intestinal worms, the eggs of which are given off in the excreta, and thereby enter the soil in regions where sanitation is primitive. Those who go barefoot in such regions take up the embryo hookworms from the soil through the soles of the feet. "Ground itch" occurs on the feet where the larvae pass through the skin. They enter the blood stream, travel to the heart, then to the

lungs, out through the bronchi to the trachea, and then down the esophagus, finally reaching the intestines, where they attach themselves to the wall, causing ulcers. Also, the larvae enter the intestinal tract directly through the mouth in contaminated water or food, or by means of hands which have touched objects soiled by infested discharges. The hookworm that infests man is not the same as infests dogs.

Constitutional symptoms occur after the worms have established themselves in the intestines. These include anemia, weakness, general debility, great hunger, and sluggishness of mind. The white race, especially children, are most susceptible. When infested before puberty, physical and mental retardation occur. Treatment, however, restores the young victim to normal, or nearly so, if begun before the growth period is over.

Hookworm was known 3,500 years ago, but its cause was not discovered until 1838. One of the first recognized outbreaks was among the laborers digging the St. Gothard tunnel in Europe. It was called "miner's anemia" at that time. It still prevails in the gold mines of Africa. The parasite thrives best in sandy soil, a somewhat moist climate, in a district away from sea water, and without long frosts. The range throughout the world is virtually from 36° north latitude to 30° south.

The disease was first recognized in this country in 1893, and first discovered to be a serious problem in 1901. A tremendous amount of work against it has been done by the United States Public Health Service and the Rockefeller Sanitary Commission since that time. The result is that in some of the rural counties showing an incidence of 36% among the white population in 1912, the incidence in 1937 was only 12%. Millions are still infested, however. The preventive methods are: proper disposal of excreta, in sanitary latrines, to prevent soil pollution; the wearing of shoes; and the cure of existing cases, for which five drugs are available. Thousands of latrines have been built at governmental expense in recent years, and curative treatment is provided free. The disease persists because of personal factors beyond epidemiological control.

***Impetigo.**

(See Chapter 41.)

***Jaundice, icterohemorrhagic** (*Weil's disease*).

This disease was first recognized as an entity in 1886. Noguchi identified the spirochete that causes it in 1916. Since then, many cases have been discovered in Europe and Asia, especially among soldiers in military campaigns, who call it trench jaundice. A few cases have occurred in the United States. Its importance in this country lies in the fact that the disease is carried by rats and that a considerable number of rats examined in this country (up to 50%) have been found to carry the organism. It is therefore possible that the disease might appear more frequently in humans. At present it seldom appears except in miners, sewer workers, and others working in damp places infested by rats. The organisms are given off in the urine of rats. Humans take the disease either through the skin or with contaminated food or water. It is a rather mild disease compared with yellow fever, which it slightly resembles. It is somewhat more severe than catarrhal jaundice, a mild and not reportable disease which may occur in epidemic form.

Influenza.

(See Chapter 27.)

the common results of gonorrhea in either sex is sterility due to stricture (closing) of the ducts that carry the sex cells.

From its original site, the disease may spread either by the blood or the lymph to remote structures. It may cause a general infection—"blood poisoning"—or infection of joints, giving acute or chronic arthritis, or infection of the heart valves. If the germs are carried on the hands, towels, etc. to the eyes, blindness may result.

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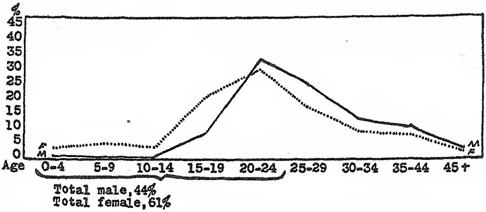

Fig. 56.—Chart showing ages at which gonorrheal infection occurs. (Data from the Massachusetts Department of Public Health.)

The diagnosis of gonorrhea is made by finding gonococci in the discharge. Conversely, cure is gauged by no longer finding them. It requires special skill, however, to be certain that none lurk in any part of the genital tract or elsewhere. As long as a single germ is being given off, the disease may be transferred to others.

Treatment for gonorrhea should be begun at the earliest possible moment, before the disease has spread. At such a time, the possibility of recovery is very good, especially in the male. Several methods of treatment are in use, according to the judgment of the physician in a particular case. The public having been informed of the frequent success of sulfanilamide in curing gonorrhea, it should also be informed that self-treatment by this drug is not safe. In the first place, the drug itself is not suitable for use by laymen; and in the second place, the layman who uses it has no way of knowing whether the infection has really been cured. Many such self-treated cases are still actively infected, not because too little of the drug was taken, but because other, or additional, treatment was needed for the case in question. After any form of self-medication, the individual is likely to remain chronically infected—a danger to himself and to others.

Hookworm Disease.

A disease due to parasitic intestinal worms, the eggs of which are given off in the excreta, and thereby enter the soil in regions where sanitation is primitive. Those who go barefoot in such regions take up the embryo hookworms from the soil through the soles of the feet. "Ground itch" occurs on the feet where the larvae pass through the skin. They enter the blood stream, travel to the heart, then to the

lungs, out through the bronchi to the trachea, and then down the esophagus, finally reaching the intestines, where they attach themselves to the wall, causing ulcers. Also, the larvae enter the intestinal tract directly through the mouth in contaminated water or food, or by means of hands which have touched objects soiled by infested discharges. The hookworm that infests man is not the same as infests dogs.

Constitutional symptoms occur after the worms have established themselves in the intestines. These include anemia, weakness, general debility, great hunger, and sluggishness of mind. The white race, especially children, are most susceptible. When infested before puberty, physical and mental retardation occur. Treatment, however, restores the young victim to normal, or nearly so, if begun before the growth period is over.

Hookworm was known 3,500 years ago, but its cause was not discovered until 1838. One of the first recognized outbreaks was among the laborers digging the St. Gothard tunnel in Europe. It was called "miner's anemia" at that time. It still prevails in the gold mines of Africa. The parasite thrives best in sandy soil, a somewhat moist climate, in a district away from sea water, and without long frosts. The range throughout the world is virtually from 36° north latitude to 30° south.

The disease was first recognized in this country in 1893, and first discovered to be a serious problem in 1901. A tremendous amount of work against it has been done by the United States Public Health Service and the Rockefeller Sanitary Commission since that time. The result is that in some of the rural counties showing an incidence of 36% among the white population in 1912, the incidence in 1937 was only 12%. Millions are still infested, however. The preventive methods are: proper disposal of excreta, in sanitary latrines, to prevent soil pollution; the wearing of shoes; and the cure of existing cases, for which five drugs are available. Thousands of latrines have been built at governmental expense in recent years, and curative treatment is provided free. The disease persists because of personal factors beyond epidemiological control.

***Impetigo.**
(See Chapter 41.)

***Jaundice, icterohemorrhagic** (*Weil's disease*).
This disease was first recognized as an entity in 1886. Noguchi identified the spirochete that causes it in 1916. Since then, many cases have been discovered in Europe and Asia, especially among soldiers in military campaigns, who call it trench jaundice. A few cases have occurred in the United States. Its importance in this country lies in the fact that the disease is carried by rats and that a considerable number of rats examined in this country (up to 50%) have been found to carry the organism. It is therefore possible that the disease might appear more frequently in humans. At present it seldom appears except in miners, sewer workers, and others working in damp places infested by rats. The organisms are given off in the urine of rats. Humans take the disease either through the skin or with contaminated food or water. It is a rather mild disease compared with yellow fever, which it slightly resembles. It is somewhat more severe than catarrhal jaundice, a mild and not reportable disease which may occur in epidemic form.

Influenza.
(See Chapter 27.)

Leprosy.

This disease, which stands in the layman's mind as most to be feared, is very rare and not particularly communicable. It is reported that only 5% of consorts of lepers develop the disease. Although the disease is presumably communicable from person to person, there is less danger to the average person from this disease than from almost any other.

Apparently the disease has changed its nature during history. In ancient times it seems to have been as communicable as the venereal diseases are today. From the 11th to the 16th century it prevailed epidemically in a serious and fatal form throughout Europe. Every town had its leper hospital. It is estimated that there were 19,000 such hospitals in Europe. For some unknown reason, it declined at about the time when syphilis first appeared. At present there are probably not more than 3,000,000 lepers in the world, and most of these are in the Orient. The disease is now a chronic one, which proves fatal in most cases, although some appear to recover.

The United States government's first leper colony was established in 1865 on the island of Molokai in Hawaii. It was presided over by the Belgian priest, Father Damien, until he died of the disease. The Federal leprosarium in the Philippines is the largest in the world.

The newest of such institutions is the National Home for Lepers at Carville, Louisiana. It provides free care for lepers from all over the United States. Most of its 350 patients are aliens, admitted to this country before they showed symptoms recognizable by Maritime quarantine officers. The patients at Carville are given treatment, and some of them are eventually paroled. This is permitted if a patient has apparently been cured, and remains so, by all available tests, for at least a year. Treatment does not cure a large number, however.

In spite of much work by scientists of the entire world, it is not known precisely how leprosy is transmitted, but it is presumed to be only by discharges from open lesions on the skin and from the nose and mouth. All the mail sent out from leper colonies is disinfected, and the personnel use every precaution against contact infection by all routes. The disease shows no tendency whatever to spread in northern parts of the United States.

Malaria.

The term malaria means "bad air," and has long been used in all lands to describe this disease which was early recognized as one that somehow came through the air outdoors. It is only since 1895, as a result of the work of Ross in India, that we have known that the disease is conveyed by the anopheles mosquito. The parasite causing the disease lives half of its life cycle in the anopheles mosquito, and the other half in man. The mosquito inoculates man with the parasites when it bites. The anopheles can be distinguished from other mosquitoes by the fact that it "stands on its head" when biting.

Malaria is an ancient disease. It was described in a Sanskrit work written 1400 B.C. and the author made the suggestion that it might be due to mosquito bites. It took 32 centuries before that observation was proved to be true. In the meantime, malaria played a part in the downfall of Greece and Rome.

Today 3½ million deaths from malaria occur annually throughout the world. Possibly one third of the world's population is infected. It has been said that malaria is the most important of all the communicable diseases, since it not only kills but weakens and predisposes to many other diseases. Osler referred to it as

"the greatest single destroyer of the human race." In our own country there were said to be 5 million cases in 1934. Although it is most prevalent in the south, it also occurs in any northern state where the anopheles mosquito can survive.

The disease is marked by "chills and fever," occurring daily, every other day, or every third day, according to the type of parasite. The parasite causes destruction of red blood cells, which gives anemia. For three centuries cinchona or its derivative quinine has been used in treatment. Recently other drugs have also been found effective. Unless properly treated, malaria may become chronic, with perhaps few symptoms. These cases complicate the problem of eradicating the disease from a community.

Prevention of malaria in a community consists of keeping mosquitoes away from both the sick and the well. The three important measures are: destroying the

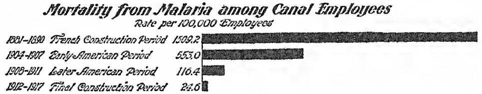

Fig. 57.—The reduction of sickness among employees enabled the United States to finish the Panama Canal. (Courtesy of the Prudential Insurance Company of America.)

breeding places of anopheles mosquitoes; the use of fine meshed window screens; and the finding and curing of existing cases from which mosquitoes acquire the parasites. Such work has been undertaken in this century by all civilized countries. The use of quinine as a preventive is of some assistance, but not always completely protective.

Measles.

This ancient disease was first called morbelli, or little sickness, to distinguish it from smallpox, which was the great sickness. All diseases causing a rash except smallpox were called by this name. Later, scarlet fever and German measles were recognized as separate diseases.

Measles still remains an important disease, chiefly because it is communicable for several days before the rash appears. It begins with the symptoms of an ordinary cold, with slight redness and watering of the eyes, and perhaps a cough. These symptoms appear about 8–10 days after exposure. They last three or four days, during which time others have been exposed to the disease by droplets from the nose and mouth or articles freshly soiled by secretions. The rash appears on the 12th to 14th day after exposure, first on the forehead and neck and then on the whole body. It lasts 3 or 4 days, and gradually fades, often with slight peeling. The disease is communicable until 5 days after the rash disappears.

The complication most to be feared is pneumonia. This is the most common cause of deaths from measles. Other complications are also common (e.g. infection of the middle ear). Measles lowers resistance to other infections, and in some cases is followed by tuberculosis in an acute form. More rarely, it may lead to encephalitis.

About 5 million cases of measles, and 10,000 deaths, occur annually in the United States. Many, if not most, of the deaths could be prevented by prompt use of one of the forms of serum now available for use after exposure to the disease or at the very onset of symptoms. Such serum can be administered to the exposed so as to

prevent the disease entirely or to make the attack lighter. All those who have not had measles should consider themselves susceptible. If an adult has not had measles it may be because of lack of exposure. Those from rural districts or from sheltered homes often take it when they first begin mingling in crowds in cities. It is possible to have a second attack of measles, although this rarely occurs.

Meningitis, meningococcus.

This disease is neither very common nor very communicable. Not all people appear susceptible to it. In fact many people harbor the organisms in nose or throat without being made ill by them. However, these carriers may give the disease to others, especially when groups are crowded together in unsanitary conditions. Occasionally, it must be supposed, a person himself falls victim to his own previously harmless germs, especially when "run down" or after being chilled. Frequently it is impossible to trace one case from another case or a carrier.

After a brief incubation period (2–3 days), the disease begins with symptoms of a cold in the nose or throat, fever, and headache. A slight rash appears shortly. The germs travel by the blood stream to the brain, at which time various brain symptoms appear. If treated promptly (by serum or antitoxin or sulfanilamide, according to need and availability), the chances of cure are good. Before serum was available, the fatality was 80%. The disease remains communicable to others (by nose and mouth secretions) as long as meningococci are being discharged. The prevention of this disease is by general hygiene and sanitation.

(Meningitis may be caused by other organisms than the meningococcus, but other forms of the disease are not communicable disease entities.)

Mumps.

This disease is also called parotitis because it involves chiefly the parotid glands, the salivary glands located just in front of the ears. It may also involve the other salivary glands under the tongue and lower jaw, the mammary glands (breasts) in either sex, and the sex glands. The latter complication is particularly serious, since it may lead to sterility. Although more common in children, mumps does occur in adults. An epidemic of it occurred in the American Army in 1918.

The disease is due to a filterable virus, given off in droplets from the ill during the entire time while the glands are enlarged, and for a short time before then. Others take the disease by contact with secretions or with articles freshly soiled by them. The incubation period is 12–26 days. Second attacks may occur.

Convalescent serum given after exposure may prevent the disease or lighten the attack, but does not help if given after the disease has begun. Most cases, however, recover fully unless complications occur. The patient often feels well, but should be in bed under medical care because of the serious nature of some of the complications.

Paratyphoid Fever.

This is one of the diarrheal diseases, somewhat resembling typhoid fever. Several different organisms may cause it. The incubation period is 4–10 days. "Summer complaint," or "food poisoning," or "ptomaine poisoning," or infantile diarrhea, may be due to the paratyphoid organisms. The disease is common, but not often fatal in adults. Care is needed to make sure that it is cured, or the patient may remain a carrier. Vehicles of transmission are infected food, water, or milk, or articles contaminated by excreta from cases or carriers. Flies may play a part as

vectors. Public health control of this disease is the same as for typhoid fever and other intestinal infections.

Plague.

This is a disease primarily of rodents, especially of rats and squirrels. It is carried from rodents to humans by fleas. The germs in the rodent are taken up by the flea while biting, and later inoculated into man in the same fashion. The disease occurs in three forms; bubonic, septicemic, and pneumonic. The latter is invariably fatal, and the two former very frequently so.

Plague is the disease that was known in the Middle Ages as the "Black Death." At that time it was pandemic for four years, and is supposed to have killed half the population of the world. From the 6th to the 17th century, plague was hardly absent from Europe. Its last stand in Europe was in London in 1665. DeFoe has described its horrors in his "Journal of the Plague Year." That epidemic was brought to an end by the great fire that in 1666 destroyed most of London. From that time onward, plague disappeared from Europe. However, a focus remained in the Orient, and in 1894 a serious epidemic broke out in Hong Kong. Ships bearing infected rats brought the disease to New York in 1899 and to San Francisco and New Orleans in 1900–1902. It persists in this country chiefly as an endemic disease among ground squirrels in California; hardly a human case has occurred since 1928.

Plague still persists in the Orient and in some of the South American countries, and might easily become epidemic here if it were not for vigilant maritime quarantine to prevent the entrance of plague-bearing rats. In all seaboard cities, rodent control is of importance.

Pneumonia.

(See Chapter 27.)

Poliomyelitis.

The common name of this disease, "infantile paralysis," is not very satisfactory for there may be no lasting paralysis and the disease is not confined to infants. It is a disease due to a filterable virus which attacks chiefly the nerve cells in the spinal cord supplying motor impulses to the muscles of the extremities, most often the legs. Occasionally the motor nerves governing breathing are also involved.

The disease usually begins with minor symptoms such as a sore throat or digestive upset, or pain in the abdomen or extremities. There is slight fever and headache. The patient will be unwilling to bend his head or spine forward. Paralysis or muscle weakness come on in one or two days. Usually it is at its worst at the start. Nearly half of the paralyses recover entirely. Proper treatment of the weakened muscles makes a great deal of difference in the ultimate result. Usually deformities can be prevented to such an extent that the patient will be able to walk, although perhaps requiring braces or crutches. Convalescent serum does not appear to be useful in treatment.

It is thought that poliomyelitis is spread in much the same way as the common cold and other diseases of the respiratory tract—chiefly by droplets from the ill. At the time of an epidemic, prevention consists of avoiding any direct or indirect contact with those who have the disease or have had it within a few weeks, and with those closely associated with the ill. As at all times, it also includes avoidance of *any* of the common ways of taking infection. No specific preventive measure effective in humans has been discovered. Not all people are susceptible, possibly

because they have become immune as a result of repeated exposure to a strain of virus not strong enough to make them ill, possibly because of some type of natural immunity.

Psittacosis.

This is a disease of birds, especially those of the parrot family, to which man is also subject. The disease begins with chilliness, fever, and cough. In 20–50% of cases, pneumonia occurs and is fatal. Although rare in humans, the disease is considered a definite public health menace, owing to the large number of birds who are infected. Any sick bird should be suspected of having this disease, and should be reported to the local board of health. Even apparently well birds recently imported have been the source of human cases. The disease appears to be extremely communicable. While studies of it were going on in 1930 at the National Institute of Health, eleven persons took the disease and four died of it, although some of them had not been near the birds themselves. The virus is in the sputum of humans ill with the disease, but few cases in humans have been traced to other humans. Some persons seem naturally resistant to it. Public health efforts to control the disease include restrictions upon the importation of birds.

Puerperal Infection.

(See Chapter 44.)

Rabies.

This disease is popularly known as hydrophobia. It is a disease chiefly of dogs, although it is not uncommon in cats and other animals. Man acquires the disease through the bite of a rabid animal. In some states, any dog bite is reportable to the board of health.

When bitten by an animal, it is important that the animal should not be shot, but kept under observation by a veterinarian for 7 days. If it does not develop rabies in that time, the person bitten will not have been infected with rabies and will not need rabies treatment. Conversely, if the animal does become rabid within a week, the person was probably infected, and should be given the Pasteur prophylactic, or anti-rabic, treatment at once. Not all persons bitten by a rabid animal will have the disease but if they do have it it will be fatal.

The treatment itself is not without some danger. Therefore, it should only be given when it cannot be proved that the animal did not have rabies. If such proof is not available (e.g. if the dog runs away), it must be assumed that the dog did have rabies.

One city has given 42,947 anti-rabic treatments in the past 17 years with only 0.06% of deaths. The treatment produces active immunity which develops more rapidly than the disease. However, it must be started within a few days after the virus has entered the body, especially in the case of bites on the face or head.

Public health measures to prevent rabies consist of licensing of dogs and doing away with stray dogs, quarantine of imported dogs, and restraint or muzzling of dogs in infected communities. Vaccination of dogs against rabies is recommended as an adjunct to the other measures. The one-dose method of vaccination is not generally favored. The state of Michigan distributed 6,226 packages of the approved seven-dose vaccine in the first 7 months of 1939. The state of Alabama has probably done the most extensive dog vaccination (220,000 dogs vaccinated in 1937 and 134,000 in 1938).

***Ringworm.**
(See Chapter 41.)

Rocky Mountain Spotted Fever.

This disease is also known as tick fever, because it is transmitted by the bite of a tick. It is a comparatively new disease, first described in 1899 in the region for which it was named. Since that time it has been recognized in 31 states. In the west it is carried by the wood tick, and in the east by the dog tick, although not the common brown tick. No other vectors are known, although various animals besides the dog serve as hosts (rabbit, woodchuck, field mice, etc.). In districts where this disease occurs, the boards of health provide instructions regarding its prevention.

***Scabies.**
(See Chapter 41.)

Scarlet Fever.

This disease occurs far less frequently than formerly, and those who have it are much more likely to recover. Nevertheless, it is still a personal and a public health problem. The chief difficulty in preventing its spread is that the disease is communicable for 1–3 days before the rash appears, while the patient has a sore throat not unlike any other sore throat. The disease is given to others chiefly by droplets as long as the germs (hemolytic streptococci) are being discharged, usually for about three weeks. "Peeling" usually occurs, but the scales are not infective. Complications are common. The disease may involve the ears, sinuses, kidneys, joints, and especially the heart. The latter is invariably serious, and may lead to chronic heart disease.

According to the Dick test, most children are susceptible, and should be actively immunized. Passive immunization after exposure may either prevent the disease or mitigate it. For treatment, a serum, an antitoxin, and sulfanilamide are available. Second attacks are rare.

The germ of scarlet fever belongs to a group which also produces several other infections (septic sore throat, erysipelas, puerperal fever, and perhaps rheumatic fever). The germs are spread largely from the mouth and nose, or other lesions of the infected, or by articles freshly contaminated by them. Unpasteurized milk and milk products, contaminated by a case or a carrier, have often been the source of epidemics of scarlet fever.

Septic Sore Throat.

The germs causing this disease are of the same group of hemolytic streptococci as cause scarlet fever. In fact many cases of this disease are thought to be scarlet fever without the rash. The disease may be mild, or severe and sometimes fatal. The symptoms are those of a severe sore throat. There is a tendency for the glands of the neck to become infected, and in some cases to form abscesses.

Frequently epidemics of this disease have been traced to contaminated milk. The first of such epidemics, in 1911, was due to milk of the finest quality except that it had not been pasteurized. This epidemic did much to show how important this final protective measure is, even for the best of milk. In many epidemics, however, the spread is from person to person by droplets. The treatment is along the same lines as for scarlet fever.

Smallpox.

Nearly five thousand years ago, smallpox was prevalent in Egypt, and it continued to be prevalent throughout the world until Edward Jenner discovered vaccination in 1798. Since then, vaccination has saved more lives than any other medicine or preventive measure ever used. Before that time, 95% of persons had the disease, and a fourth of those who had it died of it, the rest being pock-marked for life. Ben Johnson said "Envious and foul disease, could there not be one beauty in an age and free from thee?"

In many countries where vaccination is compulsory, scarcely a case of smallpox occurs year after year. The United States is the only country, among comparable nations, in which the disease still prevails widely. It was reported that throughout the world in 1938 there were 137,856 cases of smallpox and that one-tenth of these were in the United States, the rest being largely in the Orient. The reason for

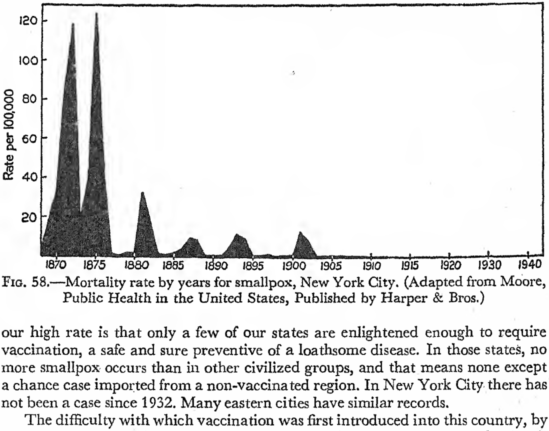

FIG. 58.—Mortality rate by years for smallpox, New York City. (Adapted from Moore, Public Health in the United States, Published by Harper & Bros.)

our high rate is that only a few of our states are enlightened enough to require vaccination, a safe and sure preventive of a loathsome disease. In those states, no more smallpox occurs than in other civilized groups, and that means none except a chance case imported from a non-vaccinated region. In New York City there has not been a case since 1932. Many eastern cities have similar records.

The difficulty with which vaccination was first introduced into this country, by Dr. Benjamin Waterhouse, of Boston, is matched by the difficulty in having it generally adopted even a hundred years later. Although no one today believes that the inoculation with cowpox will "turn people into cows," many just as ridiculous superstitions still prevail about its harmful effect. The fact is that vaccination has been done millions of times all over the world, and all authorities agree that the dangers are practically nil, provided the individual keeps the scratch from becoming secondarily infected—that is, uses the same precautions as for any scratch. It is declared that there is no state of health in which vaccination is unsafe.

Furthermore, if done by the modern scratch method, vaccination leaves no disinfiguring scars, again unless the wound becomes secondarily infected. The usual site is the upper arm, but it may be done on the upper outer part of the calf of the leg, if special precautions are used not to infect the wound.

The first time vaccination is done, the local reaction will be redness followed by a scab which is shed in two or three weeks. On subsequent vaccination, the process will be briefer and the local reaction smaller. When immunity is complete, there will be a slight but definite local reaction typical of immunity. If there is no evidence of "take" the process should be repeated until a reaction occurs that indicates immunity.

It is recommended that the first vaccination be done in infancy. In France, the vaccination of the new born infant is widely practiced. A second vaccination should be done in about 5 years, and others at five year intervals thereafter. In the later vaccinations, the brief immunity reaction is likely to occur. If a case of smallpox occurs in a community, wholesale vaccination is recommended. After exposure, vaccination within three days usually protects.

Smallpox is transferred by direct contact with the ill or with articles contaminated by any of the discharges from the ill, including the skin lesions. The incubation period is 8–16 days. It so happens that most of the smallpox today is mild, but it does kill and disfigure and cause blindness, and in some parts of the country is a major threat to health. By more general vaccination, the disease could be entirely wiped out in this country as it has been in such countries as Greece and Turkey and, in fact, almost everywhere but in the United States.

Syphilis.

This disease received its name from Frascatorius who in 1530 wrote a poem about it, in which he attributed it to an unfortunate constellation in the heavens. Before then it had been called by various names. At that time it was an exceedingly malignant plague throughout Europe, and each country had named it after some other country—but all agreed that it came to Europe with the return of Columbus and his sailors from the newly discovered America.

Fig. 59.—Paul Ehrlich, bacteriologist, 1854–1915. (Hoffman LaRoche.)

At that time no better theory of its cause was available than the one offered by Frascatorius, although it was early recognized to be contagious through sex relationships, and Paracelsus noted that infants were often born with it. Probably no disease has ever had more books written about it than syphilis. It was a new and terrible scourge at the time printing was invented, and the new art was much used to circulate medical opinion regarding it.

Beginning in 1905, a series of important discoveries made possible the degree of control we now have over this disease. First, Schaudinn and Hoffmann discovered the causative organism, the treponema pallidum, or spirochete. Next, Noguchi succeeded in cultivating the organism outside the body, which paved the way for Wassermann, in 1907, to devise the first blood test for diagnosing the disease. Then Ehrlich produced the first successful preparation of arsenic, which is the basis of our present successful treatment of the disease. Within a few years, every disease was investigated for its relationship to syphilis, and it was found that many diseases previously not suspected of such relationship, actually were a part of it (e.g. one type of mental disease).

Aside from intrauterine infection, by far the largest percentage of syphilis is acquired through sex relationships. However, contact with contaminated articles

such as drinking glasses is an occasional cause. So also is kissing. The latter possibly was noted as far back as the 16th century. A leading authority has estimated that in about 5% of syphilis the first lesion is in the region of the mouth.

After an incubation period of 10 days to 6 weeks, the disease begins as a local lesion, called a chancre, located wherever the germs enter. It varies in appearance from a small pimple to an ulcer somewhat resembling a "cold sore." In the female, this may be in a location where it is not discovered. The chancre heals after a time, whether treated or not. But it is only the first stage of the disease. Oliver Wendell Holmes was the first physician to describe the various stages of this disease.

The second stage appears in 3–6 weeks after the first. The symptoms may be slight or numerous. They include the following: small whitish sores inside the mouth, a rash, sore throat, fever, loss of hair, small flat warts on the genital organs, pains in the bones and joints, and involvement of the eyes, the ears, or the meninges. Not all persons have all these symptoms, but the majority have the first and several others.

The third stage is marked by the invasion of important organs—the brain, spinal cord, heart, blood vessels, spleen, etc.

A fourth stage appears years later (5–30 years). The end result of the destruction that has been going on finally is shown especially in the nervous system (as paresis, locomotor ataxia, etc.) and in the circulatory system. It is reported that one tenth of all mental disease and one seventh of all blindness is due to syphilis.

To prevent this entire sequence of events, or death at some stage along the way, syphilis must be discovered early and treated early. A large proportion of cases can be cured and will remain cured if proper treatment is begun in the first stage and continued long enough. The germs are at first local. In a few weeks they have spread through the entire body, and the chances of cure become proportionately less. It is estimated that not more than 3% of cases come under treatment during the first 10 days.

The diagnosis of syphilis is made during the first stage by dark field microscopic examination of serum from the chancre. A blood test (Wassermann, Hinton, Kahn) is not used at that stage, for it is a test of antibodies, and these are not present in the blood until 2–3 weeks after the chancre appears.

The disease is communicable to others from the lesions of the first and second stages, from the blood as long as the organisms are present, and from open syphilitic lesions at any stage. Prevention of syphilis is by avoidance of exposure, chiefly by the avoidance of illicit sex relationships. It is safe to assume that all the sexually promiscuous become infected sooner or later. Local prophylaxis cannot be relied upon fully.

The treatment of syphilis, even when begun early, is a long process. It consists of weekly injections for a period of 70 weeks without an intermission, an arsenic preparation first and bismuth later. The blood test becomes negative before the cure is complete. Shorter methods of treatment are still in the experimental stage.

Throughout life, the syphilitic patient who has recovered must be under medical observation for evidence of a relapse or late symptoms, which treatment does not always prevent. If such occur, treatment must be resumed. The late manifestations cannot be cured, but treatment may hold them in check, or even partly relieve them. Fever treatment, now used for a number of other diseases, was first used in the treatment of brain and nerve syphilis, and is often effective. Free diagnosis and treatment is provided by state and local boards of health all over the country.

Unless cure has been thoroughly established for several years, the individual who has had syphilis may not marry without danger of transmitting the disease to the mate and the offspring. Over 60,000 syphilitic babies are born in this country each year, of which 25,000 die in the first year. In addition, there are annually 25,000 still births due to syphilis. Of those babies who do not die, many are crippled or maimed in body or mind. Nearly all of this havoc is preventable, if the mother is properly treated during pregnancy. In 18 states, a premarital examination is required for both sexes, and in 17 states a prenatal examination is required for all expectant mothers. Under these laws, at least one syphilitic woman has been sent to jail for marrying, infecting her husband and baby and refusing treatment.

The mortality from syphilis in the United States annually is computed to be 100,000, of which 25,000 are deaths in infancy from congenital syphilis, and 40,000 are deaths from syphilitic heart disease. It has been computed that at age 30 the syphilitic has an expectation of life 7 years shorter than the non-syphilitic, for which reason insurance companies require an extra premium from those who have had syphilis.

The United States Public Health Service has stated that 6,500,000 men, women and children in the United States, or 1 in 20, have syphilis, and that 1 in 10 born alive today will have the disease before 50 years of age. Only 1 in 250 syphilitics are under treatment at any one time, a small fraction of those who need it. There are 500,000 new cases per year. In various groups, those showing positive blood tests range from 0.2% to 30%. Tests of large numbers of college students have shown only 1 in 500 infected.

Two hundred years ago Voltaire suggested an international antisyphilitic association "to unite in the fight against mankind's worst enemy." Such an organization has not been formed but many countries have waged national campaigns against it, with much success. For example, in the Scandinavian countries today it is reported that only one twenty-fifth as many new cases occur annually as in the state of New York, with about the same population.

In this country, a campaign was inaugurated in 1936 by Surgeon General Thomas Parran, M.D., with the cooperation of the entire medical and public health professions, and many leaders in other lines. Much progress has already been made. For example, the number of treatment centers increased from 713 in 1936 to 1773 in 1939. Also, the number of patients and the number of doses of medication doubled. It is believed that this disease can be brought under control.

Tetanus.

This disease is popularly known as lockjaw, because it causes painful contractions of the muscles of the jaw and neck and later of the rest of the body. Before antitoxin was introduced, tetanus was always fatal. Today, antitoxin is given after wounds that are contaminated by soil or street dust, and after penetrating wounds, including those produced by gun shot. The germs, which have their habitat in the intestinal tract of animals and humans, exist in the soil in spore form. When introduced into a wound, especially one that furnishes the "airless" medium they prefer, they produce toxins. In addition to antitoxin, the treatment includes special care of the wound.

It is possible to be partially immunized against tetanus by the use of a toxoid. Although it does not give complete immunity, it is recommended for protection against infection from minor wounds such as would not ordinarily be considered

serious enough to be treated by antitoxin and yet may occasionally cause the disease. Toxoid immunization does not do away with the need for antitoxin in the case of wounds definitely suspected of contamination with tetanus bacilli.

Trachoma.

(See Chapter 38.)

Trichinosis.

A worm infestation of hogs. Several million humans in the United States are said to be infected, through having eaten undercooked pork products. Since no practical way has been found for inspecting pork for such worms (trichinellae), the only protection against the disease is by refraining from eating any pork products, fresh, pickled, or salted, that have not been thoroughly cooked.

Tuberculosis.

(See Chapter 27.)

Tularemia.

A disease first recognized in this century. It is a disease primarily of rabbits and other small animals, and is transmitted to man by the bites of blood-sucking insects (wood tick, dog tick, and horse fly) that feed first on infected animals. Also, it may be transmitted by eating undercooked flesh of infected rabbits and hares, and even by handling such animals. The organism was first identified in Tulare County, California; hence its name. Since then, human cases have been reported from 46 states. Apparently the disease is not transmitted from man to man. Recovery takes place unless complications such as pneumonia arise.

Typhoid Fever.

Formerly one of the most serious public health problems, typhoid is now kept under control largely by means of municipal sanitation, including sewage disposal, water purification, pasteurization of milk, and food inspection; and by means of prophylactic typhoid vaccination.

Since 1911 typhoid fever has dropped from 4th to 12th place as a cause of death from communicable diseases. Yet it is still important. It is responsible for about one-half as many deaths as automobile accidents.

In this country, typhoid fever is the major disease transmitted through intestinal excreta, and the major diarrheal disease. Clinically, typhoid fever is a prolonged general disease, with fever and usually considerable wasting. It is often fatal, although modern methods of treatment have improved the possibility of recovery.

When typhoid occurs in cities today, it is usually traced to food infected by a carrier of the germs. Such a carrier may be a person who has had the disease recently, or some time in the past, or who is not aware of having had it. One of the important methods of controlling this disease is to make sure that no recovered case is allowed at large until he is no longer a carrier. Small epidemics traceable to carriers are not infrequent. General inspection of food handlers would help to solve the problem of typhoid and of lesser intestinal infections.

In rural districts, the most important cause of typhoid is still a water supply contaminated by excreta not properly disposed of. For 11 successive years there has been no water-borne epidemic of typhoid throughout the whole of New York state, largely as a result of education of rural residents by the state department of health.

In 1914 Jordan formulated the following rules for personal protection against typhoid fever. Many of these rules are also applicable to other diseases due to intestinal bacteria. They are as follows:

"1. Keep away from all known or suspected cases of typhoid.

"2. Wash hands thoroughly before meals. Do not use roller towels.

"3. Use drinking-water only from sources known to be pure, or if this is not possible, use water that has been purified by municipal filtration or by hypochlorite treatment or by boiling in the household.

"4. Avoid bathing in polluted water.

"5. Use pasteurized or boiled, instead of raw, milk.

"6. Select and clean vegetables and berries, that are to be eaten raw, with the greatest care.

"7. Avoid eating fat raw oysters and, in general, oysters and other shell-fish whose origin is not known.

"8. Be vaccinated against typhoid in all cases in which any special exposure is known or feared."

Since exposure may occur, even in well regulated cities, many physicians advocate routine typhoid vaccination every two years. Special need for it arises in the case of residence or travel in rural districts with primitive sewage disposal, as, for example, its disposal into a lake also used for drinking water and for bathing. Typhoid vaccination is entirely safe for most people, and seldom produces severe reactions. Its wide use in armies is considered responsible for a large part of the decrease in recent wars as compared with those of previous centuries.

Typhus Fever.

This disease was formerly confused with typhoid, chiefly because of the stuporous condition that prevails at the height of the disease. It is louse-borne from man to man, and flea-borne from rats to man. To gain the information we now possess about this disease eleven research workers have lost their lives, among them Ricketts, whose name has been given to the class of germs (Rickettsia) causing this and certain other diseases such as Rocky Mountain spotted fever. Typhus fever is largely a disease of wars. Delousing is one of the essential features of army life. Typhus occurs, however, in civilian life, and anti-rodent work is an important part of the health program in some of our states.

Undulant Fever

A disease of animals, especially cattle, goats and swine, to which man is subject. It occurs largely among those who work with infected animals, although cases have been traced to unpasteurized milk of cows or goats. Many states are cooperating with the Federal government in eliminating infected animals in dairy herds especially. Those particularly exposed to the disease may be vaccinated against it.

Venereal Diseases.

The term venereal is an ancient one, derived from Venus, the Roman goddess of love. It is applied to those diseases that are transmitted chiefly through sex relationships. Some states have adopted the term genito-infectious for this group of diseases.

The major venereal diseases are *syphilis* and *gonorrhea*, each of which is discussed under a separate title. In the group are also three other diseases of considerable significance.

Chancroid is a contagious venereal ulcer, which usually remains local. Adjacent glands may be involved, and secondary infection may cause suppuration.

**Lymphogranuloma inguinale* and **granuloma venereum* are two comparatively new venereal diseases. Both are common in the southern part of this country, and occur elsewhere. Either may cause years of invalidism or even hospitalization.

The first serious attack upon the venereal diseases in this country was made in 1912, by the New York City Board of Health. The following year, these diseases were made reportable in 4 states. In 1918 a Division of Venereal Diseases was created in the United States Public Health Service and in several states. Today, venereal diseases are everywhere reportable, and a large amount of public health work is being done to eradicate them. Statistics show that they are decreasing, but not at a rapid rate.

The object to be attained by having venereal diseases reportable is to make sure that the patient continues treatment until well. This purpose is served by having the case reported by number rather than by name, the number being kept confidential by the physician as long as the patient continues necessary treatment. If a patient goes to another doctor, he takes his number with him. As long as the board of health is acquainted with the fact that Patient No. X is under the care of a physician, it does not require that the name be disclosed. This system, or another similar to it, is used in many states.

The chief epidemiological problem in connection with the venereal diseases is that their spread depends upon personal factors under the control only of the individual.

Public health authorities are relying upon (a) education of the public regarding the seriousness of these diseases, their mode of spread, and the large number of persons infected; (b) clinics for free diagnosis and treatment; (c) "Education in matters of sexual hygiene, particularly as to the fact that continence in both sexes and at all ages is compatible with health and normal development." (Quoted from the handbook on "The Control of Communicable Diseases" published by the American Public Health Association, the official organization of all public health workers.)

*Vincent's Infection.

(See Chapter 42.)

Whooping Cough.

The newborn lack the relative immunity to this disease that they often have for measles, diphtheria, scarlet fever and mumps. As a result, they often take the disease early in life. Eighty per cent of the deaths from this disease occur in children under 1 year of age, and nearly all in those under 2 years of age. The disease is serious, however, at whatever age it occurs, for it may be followed by pneumonia and may predispose to other infections. Whooping cough, like many other infections, begins with the symptoms of a cold, which last up to 10 days before coughing begins. It remains communicable for three weeks after the typical cough appears. It is transferred by droplets and by articles freshly soiled with discharges from the ill.

Many physicians routinely vaccinate young babies against whooping cough. In some cases, this gives a high degree of immunity; in other cases, it lightens the attack. After exposure to the disease, passive immunity may be conveyed by means of serum. After the disease has begun, serum may still be of some use if given before the stage of paroxysmal coughing.

Yellow Fever.

This disease has been banished from this country. The last epidemic was in 1905. No case has occurred in North America or Puerto Rico for many years. Owing to the work of the International Health Division of the Rockefeller Foundation, yellow fever has also been eradicated from many lands. Only two foci of this disease remain, the original focus on the west coast of Africa, and certain rural parts of tropical America. This result was achieved through the discovery of the vector of the disease—a particular kind of mosquito—and sanitation to prevent the breeding of that mosquito.

Chapter 8

PHYSICAL INJURY AND FIRST AID

Kinds of Trauma.

The word trauma is applied to all sorts of injury to the body by physical agents. Trauma may come from without the body as a result of any of the physical forces of nature—mechanical, thermic, electrical, etc. It may also come from within the body when one part exerts an adverse mechanical effect upon another part.

The types of trauma include the following, to be discussed in this chapter: fractures of bones, dislocations and sprains of joints, rupture and strain of muscles, contusions or bruises, wounds of skin and underlying tissues, burns, suffocation, and electrocution.

The effects of trauma vary according to the amount and kind of tissue injured, the constitutional reaction of the injured person, and of course, the treatment.

First Aid.

The necessity of rendering first aid to one's self or another occurs frequently in the life of nearly everyone. To do the right thing is no more important than not to do the wrong thing. In this chapter only a few suggestions are given. To be well equipped to deal with emergencies when a physician is not available, one should make use of textbooks or manuals of first aid such as that published by the American Red Cross.

Fractures.

When violence is applied to a bone, it may cause either contusion (see below) or fracture. The term fracture means break. A bone is broken whether it is merely cracked or completely shattered.

Bones heal readily by the formation of new bone, but to make sure that the part is as strong and useful as before, the fragments must be placed together (i.e. the fracture be set), either by manipulations by the surgeon's hands, or by a surgical operation. The fragments are held in place until healed, by means of a plaster of Paris cast, or splints, or other retaining dressing.

If fracture is suspected (e.g. limb limp and distorted), the victim should not be moved at all if a physician can be brought to him.

To move him may cause the sharp ends of the bone to cut blood vessels or nerves. If he must be moved, the greatest care must be taken not to disturb the injured part. A temporary splint may be made of board padded with any soft cloth that is available.

The most serious type of fracture is the compound fracture, in which an end of the bone extrudes through a surface of the body. In passing through the skin, the bone becomes contaminated with bacteria in and on the skin, and when it is drawn back below the surface it will carry bacteria with it, unless in the meantime it has been very thoroughly disinfected. Therefore any exposed bone should remain exposed until disinfected by a physician.

Dislocations.

When ligaments around a joint are stretched or torn, the bones that enter into the formation of the joint are likely to take new relationships to each other (i.e. be dislocated). Such may occur as the result even of a slight wrench if ligaments are weak, but great violence may cause even strong ligaments to yield. Frequently a dislocation rights itself at the time of the accident, as the victim may recognize.

If dislocation obviously exists (i.e. bony contours changed and usual motion impossible), no first aid efforts should be made to restore the bones to their normal position, for additional damage to the parts will quite certainly be done by one who is not thoroughly familiar with anatomy. Although the victim may be uncomfortable, there is no danger in delaying treatment until a physician's services can be secured. First aid treatment of dislocations includes only cold or hot compresses to relieve pain, pending medical care.

A joint needs care after a dislocation, or it may repeatedly become dislocated, each time from less violence. Treatment is designed to allay the acute inflammation in the joint, so that it will not become chronic (with perhaps enlargement, stiffness and pain); and to permit stretched ligaments to regain their normal holding power.

Sprains.

A sprain is due to the same sort of violence as causes dislocations, and it involves the same sort of stretching or tearing of joint attachments, but with less marked change in the relative position of bones. First aid treatment consists of cold or hot applications. As soon as possible, it should be treated by a physician. A firm bandage is usually required.

Even a minor sprain should be taken seriously, in order to prevent chronic inflammation and to restore normal strength in the

part. Aside from the pain it causes, it usually does no harm for the victim to bear part of his weight on a sprained ankle or knee, or to move any sprained joint slightly. But because small fractures often occur at the same time as a sprain, not much motion should be undertaken after a severe sprain until a physician has given consent.

Muscle and Tendon Injuries.

Muscles may be divided by deep cutting wounds, or ruptured by traction, or, in the case of certain long slim muscles, by jerking motion. Surgical treatment may be necessary to unite the torn ends.

Muscles may be placed under harmful strain through over-use of them when out of training (as in playing 36 holes of golf the first day of the season). Also, muscles may be strained by awkward use of them. In some such cases, awkward use may be accidental and inevitable, as, for example, when stepping unexpectedly upon a loose plank; but in many cases it is at least partly due to poor mechanical use of the body. When a muscle is strained, sometimes its tendon will be partially torn from its bony attachment. The ailment known as "Charley horse" is either rupture or strain, of either muscles or tendons. Most commonly it follows indiscretions in sports.

Cold or hot applications, with moderate motion, will relieve minor muscle strain. If tearing is suspected, further treatment is usually necessary.

Contusion.

A contusion or bruise is an injury produced by impact, which affects any sort of tissue beneath the skin, but does not break the skin. If a contusion is accompanied by a break in the skin, it is called a contused wound.

Trivial bruises are relieved by cold compresses (cloths wrung out of cold water) followed after the first few minutes by hot compresses, or by hot soaks.

Any of the following contusions should certainly be examined by a physician:

1. Any *severe* contusion (extensive in breadth or depth).
2. Any contusion accompanied by *unconsciousness*.
3. Any *head* contusion except the most trivial. (Brain injury may follow a blow on the head, without causing skull fracture or unconsciousness.)
4. Any *eye* contusion, usually shown as "black eye." (If *vision* is impaired, the retina may have been detached.)

5. Any contusions of the trunk if there are any signs of *shock* (see page 162) to suggest that an organ has been ruptured.

6. Any contusion of any moment on the *back* or *neck*. (A small fracture of a spinal vertebra may not be suspected by the symptoms, yet it requires treatment.)

7. Contusions near *joints* if the joint is at all disabled. (Bleeding may take place into joints.)

8. Contusions of the *nails* with blood beneath. (Boring a hole through a nail to let the blood out is not a safe practice for an amateur.)

Wounds.

Wounds are injuries in which the covering membranes of the body are broken. They are: abrasions (small superficial wounds); cuts; lacerated or torn wounds; penetrating or stab wounds (of which the pin prick is the smallest sort); scratches; bites; stings; etc. Wounds may occur from the same violence that at the same time causes other injuries (e.g. fracture or contusion), in which case both types of injury must be treated.

For the amateur treatment of minor superficial wounds, the following procedures are usually safe, and often sufficient.

A. Cleansing.—If a wound contains visible dirt, it should first be cleansed, by thorough washing with soap and water if that is available, or by running water, or, if the wound is greasy, by gasoline, ether, or any household cleansing fluid. Whether visibly dirty or not, soap and water should be used if available. After the wound is clean, it should be dried, by exposure to open air or by sterile gauze, and then disinfected.

B. Disinfection.—A disinfectant should be applied in such a way as to reach every part of the wound and some of the surrounding tissue. The chemical may be applied by pouring it directly into the wound (which method is preferable in cuts and lacerated irregular wounds), or it may be applied by means of a glass rod or a swab (cotton wound around the end of a small stick). Tincture of iodine is the most satisfactory skin disinfectant, as it interferes least with tissue resistance. Usually one application will suffice, if the wound is properly cared for thereafter. The hands, and everything non-sterile, must be kept away from the wound after it is sterilized.

C. Dressing.—The sterilized wound should be covered with sterilized gauze, cloth, or bandage, secured by adhesive tape, or tied, or pinned with a safety pin. The dressing should be kept dry.

If it accidentally becomes wet it should be removed, and the wound be re-sterilized and re-dressed.

When the abraded surface is large, it may be desirable to use an ointment after the wound has been sterilized before the dressing is applied, to keep the dressing from sticking to the wound. The ointment (e.g. boric) should be applied directly from the tube, and if necessary be smoothed over the wound bv means of sterile material.

D. Inspection.—The dressing on very minute wounds may be removed in 12–24 hours for inspection, and if there are no signs of inflammation, and healing seems complete, need not be replaced. From larger wounds the dressing should be removed at the end of 24 hours, for inspection. If the dressing sticks, it may be soaked off in warm water. Adhesive attached to the skin may be loosened by gasoline, ether, or cleaning fluid. If it has been necessary to wet the wound, it should again be sterilized and dressed. If the wound has not been wet, and nothing non-sterile has touched it, and there are no signs of inflammation, a fresh dressing may be applied without re-sterilization and left in place until it is thought that healing is complete. The larger the wound, the longer it takes for it to heal.

It will be recalled that the signs of inflammation are redness, swelling, pain and heat. If these symptoms are present, a physician should be consulted. Even before the time of inspection, symptoms of inflammation may make themselves evident, and if so should receive prompt attention. Small red lines in the skin, radiating from the wounded area, indicate infection of lymph vessels (lymphangitis). This is always a sign that medical attention is urgently needed. The need is even more urgent if there is pain or swelling of lymph nodes nearby (e.g. under the arm, in case of injury to the hand).

Dressing for Wounds.

Sterile gauze folded into pads may be purchased ready for use, in individual sealed glassine envelopes. A convenient dressing for small wounds consists of a small pad of gauze with adhesive attached, ready to apply, each done up in a sterile envelope.

If no sterile goods are at hand, a clean handkerchief, or any soft, clean cloth, may be ironed until slightly scorched, and the scorched side, untouched by the hands or anything else after ironed, be applied to a wound. In an emergency, the inside of a fresh folded handkerchief may temporarily be applied to a wound. If there is doubt about the sterility of all available materials, it is

better to leave the wound uncovered, with care to keep it from further contamination. However, if severe bleeding is taking place, it would be better to take a slight chance of infection rather than a serious chance of fatal bleeding; but before applying anything non-sterile to a wound it should be certain that the bleeding is serious. A little blood often looks like a great deal to the novice.

Adhesive plaster should not be applied directly to a wound (except in special circumstances, by physicians), nor should flexible collodion. They are to be used on wounds only to hold dressings in place.

Wounds of the Feet.

First, since the feet are near the ground, they always carry, even in the most cleanly, a large number of bacteria. Therefore a wound on the foot is likely to be contaminated as soon as it occurs or to become so shortly. Second, wounds on the feet are difficult to dress in such a way as to favor comfort and prompt healing.

A wound on the foot must be cared for at once. Especially is this true of a penetrating wound (e.g. by a nail). But even small blisters, such as those caused by poorly fitting shoes, should be treated at the earliest possible moment. All foot wounds should be thoroughly sterilized. If they are on a part of the skin that is thick and horny, a long soaking in a hot antiseptic solution (e.g. boric acid) will soften the skin, in preparation for sterilization.

The type of dressing used on the foot must be such as to relieve the injured area of pressure by shoes. After applying several layers of gauze directly over the wound, a doughnut-shaped pad should be applied, with the opening the same size as the wound. (Fold several layers of gauze twice, cut off the folded corner, open, and trim the outer edge to suitable size.) Another layer of gauze should then be applied, and the whole be secured by adhesive tape so as to keep the edges from rolling while putting on the stockings.

Corns and Calluses.

It is suitable to mention corns and calluses here, because they are due to mechanical force and may become wounds. They consist of hypertrophy of the skin in response to rubbing and pressure. If improperly treated (e.g. by cutting), wounds are likely to result.

The first thing to do when a corn appears is to note which shoes are causing it and to discard them. To remove a corn, a chemical may be applied to soften it, so that, after soaking, it can be lifted out. Proprietary preparations are usually satisfactory, if directions

are followed precisely. (Most corn remedies contain salicylic acid as the softening agent.)

A callus on the sole may usually be cured by one or two applications of X-rays or carbon dioxide "snow." To prevent recurrence, correct use of the feet and correct shoes are essential.

Penetrating Wounds.

When a wound goes deep into the skin but has a small surface opening, bacteria which may have entered the wound are likely to be sealed within it when the opening closes over. They are then in an airless medium, which is particularly favorable for certain types of bacteria (anerobic), such as the tetanus (lockjaw) bacillus. Special methods must be used by physicians to sterilize penetrating wounds, and sometimes tetanus antitoxin must be given. The latter will usually be given in the case of wounds contaminated by soil, which is the habitat of tetanus organisms.

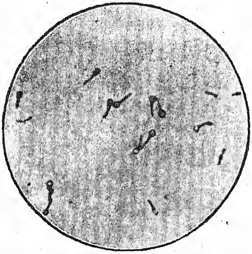

FIG. 60.—The organisms of tetanus (lockjaw). (MacNeal.)

Cuts.

A cut made by a sharp-edged instrument may sever blood vessels and bleed freely. Also the instrument may have introduced bacteria deep into the wound. After the danger of infection has been obviated by thorough sterilization of the tissues to the depth of the cut, and bleeding controlled by pressure, the cut should be dressed as a wound.

Cuts heal readily if the edges are in contact or may be brought into contact. In dressing a cut, this fact should be kept in mind. In deep or large cuts, it may be impossible to keep the wound from gaping unless "stitches" are taken to bring the edges together. Even smaller cuts in a location where a scar would be objectionable may require stitches for perfect approximation of the edges.

Burns.

Burns result either from friction (as in sliding down a rope); or heat (including electricity, etc.); or chemicals (strong acids or alkalis). From whatever cause, burns are of three degrees: first degree, skin reddened; second degree, skin blistered; third degree, skin and underlying tissue destroyed. The first aid treatment for a

small first degree burn may be tannic acid or boric ointment or any prepared burn ointment, covered with a soft dressing. The treatment of blisters is discussed below. Deeper burns, or any burns that cover a *large area*, should be treated by a physician; temporarily the part may be immersed in warm water containing a handful of baking soda to two quarts of water.

Blisters.

In a blister, the outer layer of the skin (epidermis) is raised, with fluid separating it from the true skin (dermis). The dermis is sensitive and easily infected; therefore it should be kept covered by the blister until the fluid is absorbed, or at least as long as that can be managed. To keep the blister whole, it should be covered by ointment and gauze and kept dry. If a blister must be opened, it should be done with precautions to maintain sterility (i.e. by means of a needle sterilized in alcohol or a flame). The point of the needle should be introduced at the margin of the blister, and the fluid gently pressed out. Thereafter, it should be kept covered and dry.

If the epidermis is accidentally broken and partly rubbed off, the edges may be trimmed with sterile scissors, and the area treated as a wound.

Foreign Bodies.

Foreign bodies such as splinters in the skin, if superficial, may be removed by means of a sterilized needle. The skin should be wiped with alcohol before and after the process. The area should then be treated as a wound.

If deeply situated, its removal should not be attempted by an amateur. An object that causes a deep stab wound should be left in place until conditions are suitable for removing it (e.g. in a hospital); it acts as a wedge that to some extent prevents bleeding, and a severe, and perhaps fatal, hemorrhage might occur as soon as it was removed.

If a foreign body in the eye cannot be flushed out of the eye by tears or by 4% boracic acid solution, expert treatment is required.

Complications Following Trauma.

A. Infection.—This danger has already been sufficiently stressed in connection with wounds, but it should be noted again that injured tissue is more susceptible to infection than normal tissue.

B. Hemorrhage.—Almost all trauma ruptures blood vessels, either small or large, and blood either collects in tissues or is discharged

on the surface. In either case, the tendency of blood is to clot when outside blood vessels, and the clot checks further flow of blood.

The treatment for external bleeding is pressure directly upon the bleeding area, using the hand covered with a piece of sterile gauze. Pressure should be maintained steadily until a clot has formed (a variable time, according to the type of wound and the individual's clotting time). If the flow of blood was brisk and thought to be from a large vessel, pressure should be maintained until a physician can attend to the wound. A tourniquet is sometimes necessary, but it is usually less effective than direct pressure, and may itself do harm.

A nosebleed should be treated according to the same principle. The tip of the finger, covered with a clean handkerchief, should be pressed against the middle partition of the nose (septum) where most nosebleeds originate, held motionless for two minutes or longer, and then removed gently so as not to disturb the clot.

Internal hemorrhage may result from violence which does not break the skin. It is a particularly serious condition, which may be suspected in severe injuries such as crushing blows, especially if the victim appears to be in collapse or shock. Whether the victim is unconscious or not, the first aid treatment is as described for shock.

Unconsciousness.

When a person is unconscious after an injury, the cause may be *syncope* (fainting), due to too little blood in the brain centers. This is likely to be the case if the injury does not appear to be serious, but caused fright. The treatment of fainting from whatever cause, or of a feeling of faintness, is to lower the head. The victim should be put in a horizontal position without a pillow, or, if that is not possible, his head should be lowered between his knees. There is no need of throwing cold water on him, and usually no need of any other treatment.

Fainting should be distinguished from *shock* (or collapse) which consist of a profound depression, possibly fatal, of all vital functions. Among the signs are weak pulse, shallow breathing, pallor, and cold skin. Shock should be suspected when these signs are present after (a) extensive injury anywhere on the body; (b) head injuries; (c) severe hemorrhage (although bleeding may be internal and suspected only because of the type of injury and the signs of shock). The treatment is to keep the victim lying down, perfectly quiet, and well covered. Medical treatment should be obtained as quickly as possible.

Suffocation.

Suffocation may occur as a result of foreign bodies in the trachea or bronchi (choking), or as a result of water cutting off the air supply to the lungs (drowning).

The person who is choking will ordinarily cough out the foreign body if left alone. It is mistaken kindness to interfere with his reflexes by pounding him on the back. If, however, he does not promptly rid himself of the substance, he may be placed against the wall, facing it, and slapped, not too hard, on the back between the shoulder blades with the flat of the hand. A small person may be held upside down by the feet while another person taps him. In some cases, the foreign body cannot be removed except by the fingers or instruments of a physician. If it becomes apparent that coughing is not going to be immediately successful in dislodging the foreign body, a physician's assistance should be obtained at once.

The treatment for drowning is artificial respiration.

Artificial Respiration.

The standard technique, as given in the American Red Cross manual on "Life Saving and Water Safety" is as follows:

"1. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing.

"2. Kneel straddling the patient's thighs with your knees placed at such a distance from the hip bones as will allow you to assume the first position illustrated.

Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, with the thumb and fingers in a natural position, and the tips of the fingers just out of sight.

"3. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. Do not bend your elbows. This operation should take about two seconds.

"4. Now immediately swing backward, so as to remove the pressure completely.

"5. After two seconds, swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release, a complete respiration in four or five seconds.

"6. Continue artificial respiration without interruption until natural breathing is restored, if necessary, four hours or longer, or until a physician declares the patient is dead.

"7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest, or waist. KEEP THE PATIENT WARM. Do not give any liquids whatever by mouth until the patient is fully conscious.

"8. To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the

time the patient has revived, the patient should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water or a hot drink of coffee or tea, et cetera. The patient should be kept warm.

"9. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until

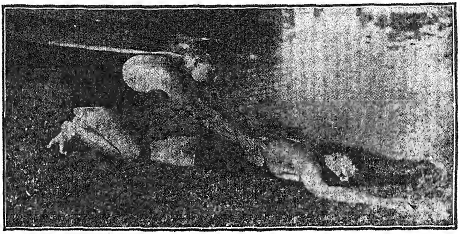

Fig. 61.—Artificial respiration—first position. Ready to apply pressure. (Courtesy American National Red Cross "Life Saving and Water Safety.")

he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, et cetera, to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

"10. A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery

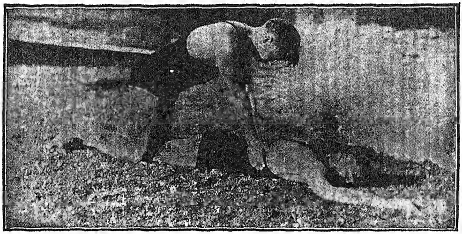

Fig. 62.—Artificial respiration—second position. Pressure applied.

of respiration, stops breathing again. The patient must be watched and if natural breathing stops, artificial respiration should be resumed at once.

"11. In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. By this procedure no confusion results at the time of change of operator and a regular rhythm is kept up."

Supplementary first aid measures are occasionally necessary. For example, if the first pressure and release indicate that air is not passing in and out, the operator must open the victim's mouth and with his finger explore mouth and throat for foreign bodies, and remove them. If the tongue has dropped backward, it must be pulled forward. If it appears that the windpipe is plugged, one vigorous slap with the open hand between the shoulders will often remove the obstruction; if not, repeated slapping will probably have no effect.

As a guide to the timing of artificial respiration, it should be noted that the normal rate of breathing in a male at rest in a calm frame of mind is about 15 times per minute; to that extent, artificial respiration may be timed by one's own breathing.

The use of an inhalator, providing oxygen and carbon dioxide, does not do away with the need of artificial respiration, which is for the purpose of making the *motions* of breathing that are necessary for intake into the lungs.

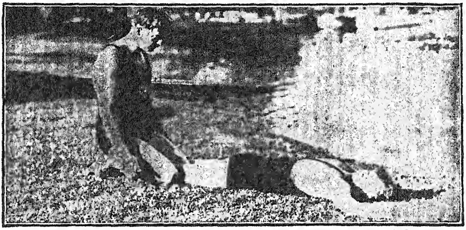

FIG. 63.—Artificial respiration—third posstion. Pressure released.

Electrocution.

The effect of electrocution is to cause cessation of breathing. It results from touching charged electric wires that are bare, or have a defect in their insulation; or from handling wires or fixtures with materials that are good conductors of electricity which render insulating materials ineffective. The body when wet is a particularly good conductor of electricity, and fatal accidents have occurred from touching electrical cords or fixtures with wet hands.

The treatment of electrocution consists, first, of removing the victim from contact with the current. This should be done *not* by touching him with the hands (or the rescuer will also be electrocuted) but with a non-conducting material, such as dry wood or a dry woolen coat. Second, artificial respiration should be used if the victim is not breathing, and continued as long as there is any chance of saving him. Third, after the effects of electrocution are overcome, and the victim is again conscious, his electrical burns should be treated.

Trauma of Internal Origin.

In many ways, mechanical force may be exerted by one part of the body against another part so as to injure it. Examples are: (*a*) pressure of an enlarged organ upon nearby organs (e.g. a large goitre may press upon the trachea so as to hamper breathing); (*b*) pressure of a sagging organ upon organs below it; (*c*) constriction of an organ, or of its inlet or outlet, or of any tubular structure, by fibrous bands or scar tissue, so as to change the normal holding capacity and the normal passage of contents, and often also to damage the parts behind the constriction (e.g. blocking of urethra, preventing free outflow of urine, and injuring bladder and general health); (*d*) torsion or twisting of one part upon another (e.g. of spinal vertebrae in curvature of the spine); (*e*) adhesion between surfaces normally separate (e.g. lining membranes of abdominal cavity around an inflamed appendix, perhaps interfering with motility of intestines); (*f*) relaxation of supporting structures, causing a decrease in the mechanical force exerted in holding parts together (e.g. relaxation of foot ligaments, causing weak feet; relaxation of spinal muscles, causing poor posture).

It is probable that the total amount of mechanical injury from within the body greatly exceeds that from without, as a cause of crippling and discomfort of minor, or even major, degree.

Chapter 9

ACCIDENTS AND SAFETY

Rates.

It is reported by the National Safety Council that 98,000 persons died in this country in 1939 of various sorts of accidents. Undoubtedly a very large proportion of these could have been prevented by the use of ordinary common sense.

The total number of deaths from accident each year in this country is nearly twice that of the loss of men in the Army in France during the World War (52,000). Computed by units of time, there are 269 fatal accidents every day, more than 12 every hour, and more than 1 every five minutes.

In addition, accidents that do not kill but disable permanently to a degree that makes a return to work impossible without assistance in rehabilitation, amount to 150,000; and lesser accidents, many of which disable to some degree, amount to 8,500,000. The United States Public Health Service in 1938 estimated that 10% of accidental injuries are permanent. The National Health Survey showed 500,000 persons disabled and not working, on the day inquiries were made, as a result of accident.

However, the rate of accidents is improving. In 1938 the rate was lower than for any year since 1900 with the exception of 1921 and 1922; and in 1939 the rate was approximately the same as 1938.

Classes.

Fatal accidents may be classified in three groups, in recent years nearly equal numerically: one-third, *automobile* accidents, in 1938 totalling 32,600; one-third, *home* accidents, in the same year totalling 32,000*; and one-third, *all others*, totalling 33,400*. Of the latter group, occupational accidents total about half (16,000).

AUTOMOBILE ACCIDENTS

Rates.

In all our wars since the nation began, approximately a quarter of a million men have been killed in battle. In the past 15 years,

* *A small proportion of these accidents were due to chemical agents.*

twice that number have been killed by automobiles. Approximately the same number are killed by automobiles in any 18 months in peace times as men of our Army in France were killed in the 18 months of the World War.

For educational purposes, the California Safety Council figured the chances of having a serious automobile accident during a lifetime. It was stated that if the 1937 rate in that state continued, one Californian in three then under legal age would be killed or injured in an automobile accident sooner or later.

The rates of automobile accidents vary according to age. Figures from the state of Michigan for 1937 show that automobile deaths are either the first, second, or third in rank at all ages from 1–40 in males. They rank no lower than eighth at any age up to 74. From 1–4 years of age, automobile deaths are exceeded only by pneumonia and other accidents; from 5–14, they are exceeded only

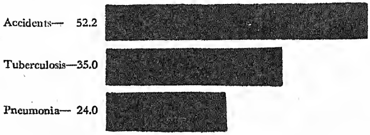

FIG. 64.—When young people of 15–19 years die of disease, it is likely to be of accident or tuberculosis. (Compiled from U.S.R.A. reports 1936.)

by other accidents; and *from* 15–29 *they are at the top of the list as the cause of death.* Considering all ages, automobile accidents caused only 4% of deaths; but at age 20, they caused nearly 30% of deaths. Many of these fatal accidents in youth are due to others' carelessness, but from age 16, throughout the country, in a large proportion of fatalities the young person himself was the driver.

However, our rates for both fatal and non-fatal automobile accidents have improved. In 1938 there were 7,000 fewer deaths than in the previous year, and 1939 held the gain. Estimating the accidents per hundred million miles of driving, there was a marked decrease between 1935 and 1939. As reported by the Automotive Safety Foundation, that rate in 1935 was 17 deaths per hundred million motor miles, and in 1939, up to October, the rate was 11. With the saving of 29,000 lives in these four years, there were also incalculable savings in disability from injury, and in property. The latter saving in the four years is estimated to be one billion dollars.

The causes of automobile accidents are the condition of *roads*, *cars*, *drivers*, or *pedestrians*, Often several of these factors combine to cause an accident.

The Driver.

If one is to be killed by an automobile it is particularly likely that its driver will be a male between 19 and 21 years of age. And it is particularly unlikely that it will be this young man's parents, least of all his mother. The male sex was responsible for 93% of fatal accidents in 1937. As for age, the report of Dr. Harry M. Johnson, of the Highway Research Board, Washington, who studied the records of over 2,000,000 drivers over a period of 5 years, shows the rate of accidents to have been as follows:

LICENSED DRIVERS INVOLVED IN FATAL ACCIDENTS PER YEAR

Age	*Number Who Were Driving When Someone Was Killed*
All ages	113.0
16	200.6
17	186.4
18	148.3
19–21	**215.0**
(then a gradual reduction to the lowest point)	
45–50	66.0
(then a rise to the average for all ages)	
65	113.0

FIG. 65.

Youth's rate of non-fatal accidents, and of property damage caused in accidents, is proportionately high.

The commonest difficulty with the driver is that he does not know how to drive. According to a large insurance company, most accidents occur with new drivers. It is said that of the 40,000,000 drivers in the country, only 2,000,000 have had any instruction in driving. To remedy this situation, 46 national organizations, and more than 40 universities now teach and train drivers.

According to many of the customary tests for skill in driving, the young show the most skill. But since they are also the ones who most often kill while driving, it must be concluded that it is judgment rather than skill that fails them. The clever young driver overestimates his skill, believing it will do more than is mechanically possible with car and traffic in given conditions. In the District of Columbia in 1936, the police had to suspend the licenses of more than twice as many between the ages of 16 and 20 as of the general

population, and the rate of suspension remained high until the age of 30.

It appears that some individuals are "accident prone." In the state of Connecticut, which keeps records of drivers' accidents, 36% of accidents in a given period were caused by 4% of drivers. The defects that are especially likely to be present in drivers who have accidents are the following: defective vision, defective hearing, defective kinesthetic sense, slow reflexes, and poor muscular co-ordination. States of mind are as important as states of the body. Many drivers involved in accidents have been found to be feeble-minded, or of heavy wits, or the opposite, excitable. Some few are definitely "queer," if not mentally ill.

In some of our states, drivers of public vehicles must demonstrate their fitness at regular intervals, in order to hold their licenses, but in general there is little to prevent an unscrupulous handicapped person from obtaining a license to drive his own car.

Alcohol and Driving.

The United States Public Health Service reported in November 1938 that traffic accidents involve intoxicated drivers or pedestrians in at least 10% of cases. The most recent report of the Committee on Tests for Intoxication, made to the National Safety Council, indicate that half the drivers killed in automobile accidents, and one third of the pedestrians killed, had been drinking.

Driving an automobile while under the influence of intoxicating liquor is everywhere prohibited. The expression "under the influence" has been defined in some states. According to the Supreme Court of Arizona, the expression covers "not only the well-known and easily recognized conditions and degrees of intoxication, but any abnormal mental or physical condition which is the result of indulging in any degree in intoxicating liquors, and which tends to deprive him (the imbiber) of that clearness of intellect and control of himself which he would otherwise possess. . . . "

A person may, however, be unfit for driving without showing it to any observer. The failure to make quick observations or prompt accurate muscular responses, or to use judgment, may occur when a person appears to be quite sober. Therefore chemical tests for the amount of alcohol in the blood are now being used in some cities and states.

From various investigations it appears that the driver with a blood concentration of 0.15% or more of alcohol is 55 times as

liable to have a personal injury accident as is one without alcohol. The National Safety Council has adopted this level of alcohol concentration as "inconsistent with safe operation of a motor vehicle," and as a level "at which prosecution should be conducted in automobile accidents and traffic violations." Many authorities believe that a much lower concentration unfits a person for driving. The Committee mentioned above advises chemical tests for the presence of alcohol in breath, blood or urine whenever the question arises in connection with accidents.

In 1916 a British committee, upon which served Sir Charles Sherrington, the physiologist, made a report which has recently been issued in a third edition, under the title "*Alcohol: Its Action On The Human Organism.*" The London correspondent of the Journal of the American Medical Association summarizes its statements as follows:

"Alcohol impairs skilled movements, and this fact is most important in the driving of automobiles. Vernon made an experimental study, by means of an artificial motor-driving apparatus, on the effects of small quantities of alcohol (from 20 to 45 cc.* in the form of whiskey) taken on a practically empty stomach, on the driving capacity of various persons. He found that by far the majority drove more quickly and more erratically than in normal circumstances. For the most part they did not realize that they were driving faster, but one deliberately drove more slowly because he realized his reduced control and several drove for short distances with a rush and then slowed down before again driving faster. There was far greater variability not only in speed but also in accuracy and carefulness after alcohol had been taken. This was noticeable even after the amount of alcohol was reduced to that contained in *half a tumbler of mild beer* (5 cc.). Some persons were certain that they were driving better although they were driving worse. Other experiments revealed not only an impairment of attention to signals and environment but also slower responses of the eyes, hands and feet."

Eyes.

From dusk to dawn, the rate of automobile accidents is higher than by day, although traffic in these hours is much less. It is believed that defective night vision (hemeralopia) is one of the causes, and that this defect is in many people due to a dietary insufficiency of vitamin A.

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* *Approximately ½–1½ ounces.*

Light falling upon the retina of the eye destroys visual purple in the rod cells. Normally, this is quickly regenerated, in a fraction of a second up to a few seconds. Its normal regeneration appears to depend upon the amount of vitamin A in the retinal rod cells. Lacking sufficient vitamin A, the individual's vision in dim light is poor, and adaptation to changes from light to dark are slow (glare blindness). Photometric tests, by suitable instruments, show a degree of night-blindness in 10–50% of those tested. Experimentation with the amount of vitamin A in the diet has shown that a deficiency (less than 100–200 units in the daily diet) makes itself evident by photometric tests in two weeks, and by clinical tests of vision in five weeks. Similar tests have shown that night vision is often restored to normal in an equal length of time by bringing the intake of vitamin A up to the normal level.

Tests for driving licenses are practically all conducted by day, and photometric tests are seldom included. It appears that such test might be of great value in limiting accidents due to poor night vision.

Other tests of vision should also be done. The Section on Ophthalmology of the American Medical Association recommends the following minimum visual standards for licensure of automobile drivers:

"(*a*) Visual acuity with or without glasses of 20/40 in one eye and 20/100 by Snellen test in the other;

"(*b*) a form field of not less than 45 degrees to both sides laterally from point of fixation;

"(*c*) ability to distinguish red, green, and yellow.

"Glasses, when required, must be worn when driving, and those employed in public transportation must carry an extra pair."

This Section recommends that the one-eyed, those with double vision, and the color blind, should not be qualified as drivers. Also, it recommends that licenses be renewed at least every three years, with appropriate tests and examinations each time.

The *one-eyed* person is hampered in three ways. First, it takes binocular (two-eyed) vision to estimate distances and therefore size of objects. Lacking two views of an object, the individual lacks the sense of perspective, upon which judgments of distance are based. Second, the range of vision is decreased from 190 degrees to 110–120 degrees. Third, the "blind spot" in the one-eyed person cuts out vision within a given range. In the two-eyed person, the "blind spots" (i.e. the spot in each eye where vision is normally lacking) do not coincide—that is, one eye sees when the other does

not. With only one eye, some spot in the range of vision will always be invisible, unless the individual keeps the head moving to obliterate the blind spot. This spot covers an area of about 7 degrees, which equals a circle 3 inches in diameter on the windshield; a circle large enough to blot out a child at 30 feet; the tallest man, at 50 feet; and another car, at 57 feet. It is estimated that 1 to 2% of American drivers are one-eyed.

Traffic Violations by Motorists.

Traffic violations are involved in two-thirds of all automobile accidents. The commonest are: exceeding the speed limit; driving on the wrong side of the road; not granting the right of way; passing on curves or hills; failure to indicate that one is stopping or turning; and failure to heed traffic signals. The first is by far the most frequent.

It appears that 40 miles an hour is the dividing line between safe driving on highways, and unsafe driving. If an accident occurs while travelling at less than that speed, the chances are said to be 1 in 44 that someone may be killed; at more than that speed the chances are 1 in 19. One of the important difficulties in driving fast is that the car cannot be stopped quickly. Mathematically, it has been computed that it is 4 times harder to stop at 50 miles an hour than at 25, and 9 times harder at 75 miles an hour. Also, the sharpness of a turn that can be made at the different speeds varies in the same ratio.

Many of the other traffic violations also arise from the desire to get ahead rapidly. In one series of inspections it was found that 1 person in 5 continues to drive after traffic signals change to red, and that 1 in 10 starts to drive before the light changes to green. According to one report, substantiated in other cities, men attempt to "chisel" at stop-and-go signals 19 times as often as women.

Traffic Violations by Pedestrians.

Approximately 50% of fatal injuries and 33% of those that are not fatal arise from collision with pedestrians. "Jay-walking" is the traffic violation responsible for the greatest number of accidents to pedestrians. A Pittsburgh investigation showed that crossing the street diagonally is three times as common among men as among women, but that the two sexes are about alike in risking crossing in the middle of a block.

One of the difficulties with pedestrians who are not themselves drivers is that they do not realize what a driver can do and what he cannot possibly do. They expect the impossible in the way of

quick stops on wet streets, etc. Also, they do not realize how difficult it is to see them at night. Since they can see the car perfectly clearly, they believe the driver can see them equally clearly.

It appears that education of pedestrians is as much needed as that of drivers. The problem is particularly difficult in regard to children, but is being met to some extent by public school training.

HOME ACCIDENTS

Rates.

The chances of having a fatal accident at home are less than while automobiling; although approximately the same number of people meet death from home accidents, the proportion of persons at home and the amount of time spent there are greater. Oddly enough, the hazard for men, who spend less time at home, is greater than for women.

In addition to the 32,000 fatal accidents at home (one every 14 minutes), 4,300,000 non-fatal home accidents were reported in 1939. Many of these were permanently disabling (one every 3 minutes). The cost of medical care for these home accidents is reported by the United States Department of Commerce to have amounted to $730,000,000.

A large proportion of home accidents are falls and burns (by fire or by scalding).

Falls.

About half of the home accidents are falls. In the case of older people, falls are more likely to take place on stairways, or on slippery floors, or over objects on stairs or floors. Over 100,000 persons a year are said to be injured in bathrooms, a large percentage being due to falls in bath tubs or on wet floors.

Younger persons, and men, are more likely to fall while climbing around a house, indoors or out. Efforts at home repairs account for many accidents such as falling from improvised step ladders, or regular ladders, from roofs, porches, balconies, windows, and the like.

Burns.

Burns, explosions and conflagrations caused 8,200 deaths in the United States in 1937. Nearly three-fourths of all burns occur in homes.

It is encouraging to learn, however, that fire losses, both human lives and property, have decreased nearly 50% since 1926. Part

of this decrease is due to regular inspection of buildings by local fire departments.

In general, the causes of fires are approximately as shown in Fig. 66, according to the figures of the National Board of Fire Underwriters for 1932–34.

Scalding by hot water is also a common cause of home accidents. One-fourth of such accidents occur among children under 4 years of age. A considerable proportion of burns by fire also occur in

	Per Cent
Matches and smoking	14
Defective chimney and flues	11
Incendiarism	10
Stoves, furnaces, boilers, etc	8
Misuse of electricity	7
Spontaneous combustion	6
Sparks on roofs	6
Petroleum, gasoline, etc	6
Spreading from original fire	15

Fig. 66.

young children, the cause usually being the carelessness of their elders.

OCCUPATIONAL ACCIDENTS

Twenty five years ago, industrial accidents engaged public interest as automobile accidents do today. Since then, they have gradually been reduced until fatal industrial accidents occur not much more than half as often as fatal accidents at home or fatal automobile accidents. In many large factories where a few years ago a fatal accident might have occurred once a month, there may not be such an accident today for years at a time. Some of the largest plants, where hazardous work is done, show records of millions of man-hours without a single disabling accident.

In the nature of things, many industries present enormous hazards, yet if these are recognized and guarded against the worker may be even safer than if he were at home or out riding. The improved rate of accidents in industry has come about largely through safety devices provided by employers and by precautions taken by employers and employees. Irénée DuPont recently stated that "It is now safer to work with dynamite than with brick." It appears that if the knowledge of extreme danger can circumvent it, the same should be true of lesser dangers.

That 18,000 fatal accidents do occur annually in industry, and that eye accidents alone in 1938 cost industry nearly $50,000,000, indicate that still greater preventive efforts are needed.

OTHER ACCIDENTS

Other fatal accidents than those mentioned total about 15,000 annually as follows.

Drowning.

Although there has been a steady decrease since 1913 in the number of deaths annually from drowning, the number is now about 7,000 per year. Among children, drowning is second only to automobile accidents as a cause of accidental death. Half the total number of drownings occur between 5 and 29 years of age. As with all types of accident, drowning is a special hazard of the male sex; nine-tenths of drownings are of boys and men. Also, it is a special hazard of those who do not know how to swim; it appears that four-fifths of those who drown are non-swimmers. Only about one-tenth of the drownings involve boats, usually small boats manned by those who do not swim.

About 200 deaths occur annually from drowning after a mechanical injury while diving, by hitting against something either above or under water.

Vehicles other than Automobiles.

Railroad trains, trolley cars and the like, not in collision with automobiles caused 4,400 deaths in the United States in 1937. The rate has been steadily decreasing since 1923. On steam railways only 36 deaths were of passengers, and only 806 of employees. Nearly half were of trespassers on tracks or on trains, and the others of persons at grade crossings. The rate per hundred million passenger-miles was only 0.09 for steam trains, as compared with 4.5 for passenger automobiles and busses.

Bicycle accidents in the past few years have greatly increased. In New York city the 1939 rate was double that of 1938 for both fatal and non-fatal accidents. One large insurance company reported that the rate for 1937 for boys aged 15–19 was 8 times as high as in 1935. During that time, only 7 accidents occurred to girls, among millions of insured. If the present number of bicycles (13,000,000–15,000,000) increases, it appears that special traffic rules will have to be made for them.

The accident rates for flying are much lower for scheduled transport planes than for non-scheduled flying. Per hundred million

occupant-miles, the rate for the former in 1937 was 8.6, and for the latter 137.4. It will be noted that as a sport flying is distinctly hazardous. Investigation of the causes of accidents in which fatalities occurred shows that in non-scheduled flying the largest cause was the aviator himself. Between 1930 and 1937 the rates for aviation accidents decreased markedly—by 41% for non-scheduled flying, and 59% for scheduled flying.

Hunting and Firearms.

Hunting accidents in which someone is killed totalled about 2,000 in 1936, according to estimates of the National Safety Council. Usually such accidents are reported to be due to mistaking a person for the animal being hunted, although a considerable number are due to accidental discharge of the gun in one way or another.

Other deaths from firearms total nearly a thousand more, of which three-fourths occur in homes, while handling or cleaning or inspecting a weapon.

Miscellaneous Accidents.

Every year in celebrating the Fourth of July, thousands of accidents occur, and a few lives are lost. It has been stated that in 30 years of celebrating our country's birth with fireworks more people have been killed than in the Revolution itself. In 1903 the American Medical Association began to record such accidents. In that year 400 deaths occurred. In 1937, 7,205 accidents were reported to hospitals, but only 20 of them were fatal.

Sports accidents appear to add little to the total death rate. According to statistics of one of the large insurance companies, grandfather taking a bath is running a greater risk than grandson taking part in college sports.

The decrease in the rate of athletic injuries is attributed to better coaching and equipment, and more frequent use of physicians in examining candidates for organized sports and for rendering first aid. The high rate of accidents in skiing is believed to be due to the fact that it is often taken up by persons no longer in condition to undergo contortion and strain with safety.

In view of the large numbers of persons playing games of all sorts, it appears that games are relatively safe for those who are in good condition and abide by the rules.

SAFETY

Many of the personal procedures for keeping safe have been suggested in recounting the causes of accidents. Without repeating

these, two points may be called to attention. First, many accidents are due to nothing more nor less than *awkwardness*. A great many persons, young and old, lack the grace and harmony of movement which comes from well-controlled muscles. Their lack of balance and accuracy of movement shows that they are not in complete possession of their muscular faculties. Undoubtedly some are motor morons, hereditarily and incurably awkward, but with many the difficulty is remediable by due physical training, and especially by acquiring pride in precision.

Second, it is quite generally agreed that the chief factor causing accidents is not any frailty of the body, but *frailty of judgment*. Again, the condition may be inborn and irremediable, but it does appear that with many people a reasonable amount of judgment is possible in the face of a real danger—provided they recognize it as such. The publicity that is annually given to the accident rates in the country is to arouse appreciation of danger in the hope that it will make the careless and heedless, the emotionally unpoised, see the need for whatever judgment they can summon.

As a public health problem, safety requires *engineering* to make all our mechanical devices, including roads, as safe as possible; *education* to show ways in which accidents occur and the means of avoiding them; and *enforcement of regulations*, in public places and wherever officials have jurisdiction, regarding safe equipment and safe practices.

Chapter 10

INJURY BY CHEMICALS

Any chemical substance that is foreign to the normal make-up of the body—either qualitatively or quantitatively—and is injurious to it is classed as a poison. Such substances may either be introduced into the body from without, or made and retained in the body (metabolic poisons). In this chapter only the former will be discussed, with a brief paragraph on the latter.

In form, a poison may be a gas or a fume, a solid or a dust, a liquid or a spray. The toxicity (poisonous effect) of a poison varies according to the nature of the substance itself; the amount received; the place where applied to the body; and the individual susceptibility of the body.

Poisons tend to destroy life or to impair health. They may injure body tissue, or impair body functions, or both.

Local and Constitutional Effects.

Some poisons produce local damage at the point where they come into contact with the body. Others do not, but are absorbed into the body and cause constitutional harm. Some have both effects.

Local effects of poisoning range from mild irritation to severe corrosive action, with actual destruction of tissue. A vast number of chemicals are more or less irritating to the skin or the mucous membranes. Such, for example, are certain soaps, cleaning powders, disinfectants and cosmetics. Some parts of the body are especially sensitive to such irritation (e.g. the eyes). Many of the lesser irritants are capable of causing severe poisoning if applied undiluted, or taken internally.

The most serious local effects are produced by the corrosive (gnawing) poisons. Among these are the strong acids such as carbolic or nitric, and the strong alkalis such as lye. They cause lesions similar to burns, with coagulation of the albumen of tissues. Disinfectants such as bichloride of mercury may give corrosive effects if used too strong. Old iodine that has become stronger by loss of fluid may be extremely irritating, if not actually corrosive.

The constitutional effects of poisons occur after the poison has entered the blood stream and combined with various tissues of the body, causing interference with their function. Chemicals having this effect are known as organic poisons. Many have both local and constitutional effects. For example, bichloride of mercury is locally corrosive, and begins to harm the kidneys within ten minutes after absorption. Many of the organic poisons have a selective action, injuring one kind of tissue or one organ in particular. Others are diffusely harmful. Several of the constitutional poisons (the narcotics) are of such importance as causes of illness or death that a separate chapter is given to them (Chapter 11).

Acute and Chronic Poisoning.

Poisons that produce an immediate or acute effect, up to the point of causing death, are numerous. In New York city in 1937, fatalities occurred from 38 different poisons. The harmful effects vary. Some cause over-stimulation of the nervous system (e.g. strychnine), but the majority cause a profound depression of the vital centers (e.g. acetanilide, a drug contained in many pain remedies).

Acute accidental poisoning accounted for 4,100 deaths in the United States in 1937, or one-ninth of the number caused by automobile accidents. The rate has been steadily declining since 1913. A comparison of these two years is shown below.

	Number of deaths		*Number of deaths per* 100,000 *population*	
	Poison gas	Poisons, not gas	Poison gas	Poisons, not gas
1913	3,467	3,221	3.6	3.3
1937	1,800	2,300	1.4	1.8

FIG. 67.

Chronic poisoning, also, may result from many different kinds of chemicals—some of the same that in larger dosage cause acute poisoning. A fatal result may finally occur, especially in the case of poisons that are cumulative—that is, those that tend to accumulate in the body, one dose having followed another before the first had been entirely eliminated. If the drug itself does not actually accumulate, its effects may, with progressively more and more damage to tissues. In some cases, chronic poisoning is simply

continued poisoning, and ceases when exposure to the poison ceases. Among the more common causes of chronic poisoning are carbon monoxide, lead, alcohol, and the narcotics, all of which are also common causes of acute poisoning.

Carbon Monoxide.

This gas is by far the commonest chemical cause of sudden death. In New York city in 1937 it accounted for 651 fatal poisonings, accidental or otherwise, out of a total of 898.

Carbon monoxide poisons because it unites with hemoglobin in the red blood cells, thus preventing oxygen from doing so. The danger is according to the degree of oxygen starvation. It is reported that dilutions of carbon monoxide as low as 0.05 per cent in the air produce symptoms, that 0.15 per cent causes collapse within an hour, and that 0.25 per cent produces death in a short time, even perhaps at the first breath, and often within one or two minutes. Sometimes acute poisoning begins with muscular weakness, which prevents the individual from leaving the spot although conscious. It is reported by Leonard Hill that those under the influence of alcohol are especially susceptible to the effects of carbon monoxide.

Exposure to carbon monoxide occurs in the home, through *leaks in gas fittings*. The New York Bureau of Industrial Hygiene stated that "Small leaks, incapable of lighting when a match is applied, are just as important as the larger ones. The fact that no one smells a leak is of no significance, because it is easy to become accustomed to the odor. Improvised patches on gas leaks are no remedy. They must be properly repaired."

All gas fixtures, connections, pipes, and tubing should be of the standard recommended by the American Gas Association. They should be tested from time to time for their tightness. Old rubber tubes are an especial danger. There should be vents from all gas stoves and heaters, connecting them with a chimney. The inside of gas pipes, and of all metal carrying gas, should be kept free from soot.

Carbon monoxide also results from *imperfect combustion in stoves and furnaces* that are improperly constructed or operated. The draughts must be manipulated so as to supply plenty of oxygen when starting a fire. Usually this means that they should be kept open until the fire is glowing. Any odor of "coal gas" requires opening of all windows at once.

A third common source of carbon monoxide poisoning is the *exhaust gas* of automobiles. Every year many deaths from this cause

occur, in spite of repeated warnings that a gasoline engine must not be run in an enclosed space lacking provision for removal of all exhaust gases.

Non-fatal poisoning from carbon monoxide is undoubtedly much more often present than is recognized. This may occur without being suspected, its symptoms being attributed to some other cause. It may even occur out of doors on a highway having heavy traffic, especially at intersections where cars stop with engines running while waiting for traffic signals. Behind a large truck or bus, the air has been found to contain 0.07% carbon monoxide, which is half as high a concentration as will cause collapse in an hour. Traffic officers at busy city intersections are most likely to be affected. It has been shown that at the end of the day they may develop headache, irritability and general feelings of illness. As yet, no solution has been reached for this problem.

Chronic poisoning by carbon monoxide is thought not to produce organic changes, but to be merely repeated and continued acute poisoning, from which the individual recovers when exposure ceases. However, continued exposure may lead to a continued condition of poor health and nervousness.

Occupational Poisoning.

Although all classes of individuals encounter poisons, the industrial worker is the one who is most likely to be exposed to chance poisoning by chemicals. Most firms, however, with a modern and humane attitude toward their employees, take all precautions to protect them.

Moreover, public health measures are being taken in most states to limit poisoning from the chemicals necessarily used in industry. Much legislation has been passed (based upon the research work of such scientists as Dr. Alice Hamilton) with a view to protecting both the workers and those who use the manufactured articles (e.g. gasoline containing lead).

The chemical that most frequently causes poisoning in those that work with it is *lead*. In such case, it most often enters the body through the mouth and digestive tract. Lead poisoning often occurs in painters and typesetters who are careless about transfer of lead particles from hands to mouth. Sprayed paint may also poison in the same way.

Apart from occupation, lead is also a danger. Fatalities from lead have occurred in the case of children who ate lead paint from their toys. Although less common now, lead poisoning may occur

from lead pipes in domestic plumbing, especially when they carry water with a high content of carbonic acid.

Chronic lead poisoning is a common disease. It caused 13% of compensated occupational disease in New York State in the period 1933–35. In one industrial plant with a special lead hazard, nearly 40% of workmen showed some degree of lead absorption.

To prevent lead poisoning when definitely exposed to it requires considerable care regarding its hand to mouth transfer. Recent reports seem to indicate that an abundant intake of vitamin C may be of assistance in addition to other methods.

Accidental Poisoning in the Home.

Poisoning at home occurs largely because certain substances in common use are not recognized to be poisonous, or are confused with something harmless.

Many disinfectants, germicides, insecticides (e.g. nicotine used on plants), and substances used to kill rats and mice, are poisons of one sort or another. So also are many polishes, cleaning pastes or fluids (e.g. some silver polishes contain cyanide), photographic chemicals, shoe dyes, hair dyes, and, of course, many medicines.

Fatalities from poisons in the home occur most frequently among children. Therefore it is highly important that all such substances as those mentioned be kept in a place by themselves, apart from harmless substances, out of reach of children, and not too readily accessible even to adults. They should be clearly labeled, and the label should be read before the substance is used. Obviously, this is particularly necessary in the case of substances taken internally. Any chemical substance that has lost its label should be discarded; it is hazardous to try to identify it by sight or smell. No dangerous chemical should ever be put into a container ordinarily holding harmless substances (e.g. a milk bottle or a drinking glass). Also, the materials and utensils used in applying poisonous chemicals should either be thoroughly cleaned or destroyed immediately after use. Finally, the hands should be protected insofar as possible while using a poison, and while contaminated should be kept away from the mouth, nose, eyes, and foods.

Medicines.

Ironically enough, most poisoning from external sources comes from the very substances taken voluntarily for their expected benefits to health. This subject is so important that it is discussed in a separate chapter (Nostrums and Self-medication, Chapter 17).

Food Poisoning.

When food has a poisonous effect it is usually not because it contains chemicals from outside sources, nor yet chemicals produced in it as a result of spoilage, but because of bacteria. Certain specific diseases caused by bacteria in food (e.g. the dysenteries, typhoid fever and paratyphoid fever) have been mentioned in Chapter 7. Many of the lesser "intestinal upsets" are of similar origin.

One of these, called "ptomaine poisoning" is commonly thought to be due to chemical deterioration of food, but that is not the case. This type of intestinal disorder is believed to be always due to bacteria. The contaminated food may give no evidence of spoilage, either in appearance, odor, or taste. A variety of organisms have been implicated. The source of the bacteria is likely to have been an infected person who has handled the food (i.e. one who had an intestinal infection, or perhaps a skin infection with staphylococci, as in a boil). Or the source may be rats, mice, or insects having access to food and contaminating it with bacteria from their surface or excreta.

A different type of bacterial food poisoning may come from contamination of food with toxins of the bacillus botulinus. This toxin is pre-formed in the food. Poisoning most often occurs from canned food that was not in proper condition when canned, was not sufficiently processed, and was eaten without further cooking. Cases occur in all countries, usually in groups of those who have eaten the same food product. Symptoms appear within 24 hours after partaking of the food. Usually the eyes are first affected, and there is no digestive disturbance. An antitoxin is available for treatment, but the fatality of the disease is high. In this country today, such poisoning occurs only from home canned foods, and not very often from them, since methods of canning have been widely taught by the Department of Home Economics of the Bureau of Agriculture. Nevertheless, botulism caused over a thousand deaths in the United States in 1938, and the rate is constant.

As for contamination or adulteration of food with chemicals, this, too, rarely occurs in the commercial preparation of food products. In general, the Pure Food and Drug Act of 1906 was effective in preventing such dangers, and the Act of 1938 will undoubtedly be still more so. For foods, the labels are to be simpler than those for drugs. The Secretary of Agriculture may designate a given article as *standard*, and it will then require no other label.

It is thought that greater danger to health may lie in what a food does not contain than in what it does contain. For example, a highly processed food may lack essential vitamins. A food will not be labelled *standard* unless it supplies all that the given food is supposed to supply.

Venomous Insects and Reptiles.

A few species of snakes and many insects inject a poisonous venom when they bite. The results depend upon the kind of venom, the amount, the place injected (whether into a blood vessel or not), and individual susceptibility. Even in parts of the country where such dangers exist, few deaths occur from such causes. For some of the more serious venoms, specific treatment is available—for example, serum for certain snake bites, and antivenin for the bites of the black widow spider.

Metabolic Poisons.

Every cell in the body secretes substances that might prove poisonous if not duly excreted, or if not properly balanced by other substances produced in the body. Nitrogenous urinary constituents if retained, may cause fatal uremic poisoning. Acidosis or alkalosis, both of which amount to poisoning, are due to a disturbance of the acid-base balance within the body, chiefly from internal causes. The diseases due to imbalance of the endocrine glands (e.g. diabetes) are essentially chemical in nature. One of the diseases of the thyroid gland is known as "toxic" goiter. The disease gout, in which uric acid, a body product, plays a part, may be classed as chronic poisoning. Many laymen, and a few physicians, believe that genuine poisoning may occur from materials retained in the intestinal tract.

In some cases, self-poisoning may result from undue loss of chemicals from the body (e.g. loss of water in diarrhoea), or by deficient production of a chemical the body should produce in larger amounts (e.g. hemoglobin, in anemia).

Self-poisoning of the body is usually due to ill health of an organ. Often it is at least partly due to faulty intake (excess or deficiency of some substance) in the past if not in the present. Therefore self-poisoning can seldom be classed as primary.

First Aid.

Whenever possible, in case of poisoning, a doctor should be called at once, or someone who has some special knowledge of the body and also of chemicals (druggist, dentist, nurse, or veteri-

narian). Only when such assistance is not promptly available should first-aid measures be used. However, everyone should be familiar at least with the following facts, for use when professional help cannot be obtained.

A. Surface Poisoning.—Chemicals that have caused burns must be neutralized, diluted, or removed, at once. Water in large quantities serves these purposes in most cases. Also, except in chemical burns of the eye, a specific neutralizing agent, if at hand, should be used (for example, a weak alkali, such as sodium bicarbonate or baking soda, should be used on acid burns, and a weak acid, such as vinegar, on alkali burns). Subsequently, a bland ointment (e.g. boric) should be applied, pending further medical treatment, if necessary.

B. Poisons Taken Internally.—(1) Artificial respiration is the remedy for gas poisoning. Also it may be needed in case of other poisons that depress respiration. According to Dr. A. O. Gettler, Medical Examiner of New York City, artificial respiration may be needed in poisoning by wood alcohol, barbital, chloral, cocaine, cyanides, morphine, nitrobenzene, and occasionally strychnine.

(2) When poison has been taken into the stomach, an effort should always be made to induce vomiting, by means of a finger in the throat, or by large draughts of lukewarm soapy water.

(3) Acids taken internally should be neutralized by milk of magnesia in preference to other alkalis, and alkalis by weak acids such as vinegar or lemon juice, or at least should be diluted by large quantities of water.

(4) If an irritant or corrosive poison has been taken (which will usually be shown by inflamed areas in or around the mouth), its destructive action should be checked by an albuminous solution (milk or egg), or a starchy solution. No harm will be done thereby, even when it is not clear that the poison was corrosive.

(5) If it is known what chemical was taken, and what its antidote is, and if the antidote is at hand, the antidote should be used in preference to those mentioned in (4), or in addition to them. The following mixture is mentioned by Dr. Gettler as a universal antidote, to be given when the poison is not known. "Mixture of 2 parts pulverized charcoal, 1 part magnesium oxide, 1 part tannic acid. Administer one heaping teaspoonful in a small glass of warm water."

Again it should be mentioned that no amateur methods of treating poisoning should be relied upon if professional aid is available.

Chapter 11

HABIT-FORMING DRUGS

The Term Habit-forming.

Drugs are called habit-forming when their use engenders a physical or mental craving for them. Like all habits, drug habits are fixed modes of reaction, established by frequent repetition.

The drugs called habit-forming are a danger because of the readiness with which habitual use is established; the compelling power they exert over the user; the difficulty in breaking the habit (if not the impossibility of doing so) by unaided power of the will; and the physical and mental deterioration that may follow a long period of addiction. In the case of all of them, overindulgence is incompatible with good health of mind or body. All are capable of causing acute poisoning by a single large dose, or chronic poisoning by the accumulated effects of repeated smaller doses.

The principle habit-forming drugs are those having a narcotic or hypnotic effect. Under separate headings the following will be discussed: ethyl alcohol; the drugs commonly designated as narcotics (chiefly the morphine derivatives and cocaine); the drugs commonly designated as hypnotics (chiefly barbituric acid and its derivatives); hashish, or marihuana; and nicotine, which is habit-forming, although its effects are somewhat different from the others.

Euphoria.

The habit-forming effect of all the drugs mentioned except nicotine is due to the fact that they have the power to blurr or obliterate the unpleasant, and to induce a sense of well-being known as euphoria. This feeling normally comes from a well body and a well mind or personality. Its absence, dysphoria, comes from faulty physical or environmental or social or emotional conditions; but it is normally dispelled by attacking the conditions themselves, and improving them, or, if they cannot be made satisfactory, by gaining compensatory satisfactions through realities of one sort of another.

To use drugs to banish dysphoria and to gain euphoria is unquestionably the easiest way—but usually the least constructive

way. It does not, as a rule, meet the present situation adequately, and it may establish the habit of using a toxic substance that may create difficulties even worse than those from which release was sought.

ALCOHOL

Our very remote ancestors discovered that sweet liquids that stand for some time will ferment, forming a substance now known as ethyl alcohol. Even as far back as the Stone Age, the process of brewing seems to have been discovered, for it is reported that beer has been found in jugs of that date. At some time before Grecian civilization began, evidently the process of distillation was discovered, for Aristotle refers to "burning water," a liquid that would ignite.

From the first, alcohol was valued as a beverage. In ancient times, it appears that men drank in a religious frame of mind, for the sake of visions and experiences interpreted as supernatural. However, it was not long before alcohol came to be appreciated as an aid to conviviality. In Ostia, the seaport of Rome, has been unearthed a bar dating 2,000 years back, with many of the features of similar structures today, including a brass foot rail.

Shortly, the poisonous nature of alcohol began to be recognized. The literature of all peoples, especially of the Hebrews, comments upon the danger of taking it too freely. During the Middle Ages, the physicians in their popular health books gave much space to warnings against the habit of alcoholism.

Such warnings are today as much needed as ever. It appears that the teachings of past centuries have been fruitful in reducing some of the grosser forms of alcoholism, but not in banishing them entirely. That problem still remains important. In addition, in this century the standards of sobriety have had to be increased. In a machine age, it is not only frank intoxication that is a danger, but the minor physical and mental changes that occur even in those who may have taken but little alcohol. Also, in an age of competition, the utmost in fitness is none too much with which to challenge success. Fitness, especially of the mind, is known to be impaired in important respects in those under the influence of alcohol.

Absorption, Action and Excretion.

Alcohol is rapidly absorbed by the stomach and intestines, and distributed throughout the body, especially in the brain. It

reaches its maximum concentration in the blood in one to two hours, depending upon the amount of food in the stomach at the time it was taken (the more food, the slower the absorption). Three to four ounces of whiskey or two quarts of beer will cause a concentration in the blood of one milligram per cubic centimeter, or roughly 0.1%.

The action of alcohol is that of a depressant. It exerts this effect upon the brain and other nerve tissue, and, indeed upon practically all tissues.

Alcohol is excreted by the lungs and the kidneys at a given rate. The amount mentioned above would be fully excreted, and the blood again be free of alcohol, in seven hours. If a second dose were taken before the first were eliminated, the blood and the tissues would continuously contain alcohol, until a sufficient time had elapsed for the accumulated doses to be eliminated.

The rate of elimination is the same regardless of muscular activity or any other measure to hasten it.

Effect upon the Brain.

The first effect of alcohol is upon the brain. The higher powers of the brain—the latest to be added in the progress of human development—are first lost. This drug, like all of the narcotics, begins by dulling the powers of attention, judgment, and discrimination. These powers represent the climax of human mental attainments. They normally guide behavior by inhibiting impulsive responses that are not acceptable to the personality as a whole or to society.

Lack of inhibition shows itself in many ways. For example, the tongue-tied may become loquacious; the reserved, sociable. How far a person may go when his inhibitions are released depends upon the person. In some, even the least lack of restraint may bring out a natural crudeness hidden until alcohol reveals it. Primitive man may appear, with all his native impulses unleashed. Conduct an individual would ordinarily consider reprehensible may seem attractive, even praiseworthy. Risks that would normally be shunned may seem perfectly safe. For example, the sort of recklessness that leads to exposure to venereal disease has long been known to be a common effect of alcohol.

As for intellectual work involving speed, accuracy and discrimination, tests show that these powers, too, are impaired, although work requiring release of imagination may be improved in range if not in quality.

The amount of alcohol that affects the brain in these ways varies with different individuals. With many, these effects appear in some degree before blood concentration has reached 0.1%.

Muscular Incoordination.

The familiar reeling gait is not the first evidence of incoordination. Long before the skeletal muscles of the legs are affected, incoordination appears in the smaller muscles, and gives varying degrees of inaccuracy in manual and visual work.

Dr. Walter R. Miles of Stanford University experimented with rats trained to run through a maze to reach their food, to determine the effect of different drugs. After alcohol, they apparently knew how to find the way out, but were not able to walk straight. After some other drugs, they could walk, but did not know where to go. One commentator on these findings remarked that no drug yet tried will produce a performance that is an improvement on the normal.

Any degree of incoordination is likely to lead to poor work, which is one of the reasons why manufacturers do not approve of having workers take alcohol. Also, incoordination is likely to lead to personal injury. In a fifteen year report of a large hospital in Boston, 16,054 alcoholic patients were received, and of these 14,668 had received injuries, as a result of accidents. Nearly 11,000 of these were head injuries, ranging from contusions and abrasions to fractured skulls.

Alcohol and Driving Accidents.

Alcohol unfits a person for driving by reducing both judgment and muscular coordination. This important subject was discussed in Chapter 9.

Acute Poisoning.

The lethal point in alcohol concentration in the blood is considered to be 5 milligrams per cc. But an individual may be seriously poisoned and unconscious, in a state of coma, before that level is reached. Death has been reported from five ounces of straight alcohol.

The person who is unconscious from alcohol poisoning needs medical treatment at once. If he recovers he will probably not have any lasting effects from a single attack. If death occurs, it will be from depression of the vital centers in the medulla. Death will not occur from spontaneous combustion, as Charles Dickens suggested in "Bleak House." When challenged regarding his account

of the death of the alcoholic rag-and-bottle dealer Krook, Dickens attempted to answer the criticism by reference to thirty such cases then on record. Modern physicians have not observed the phenomenon.

Occasionally death occurs because of the simultaneous use of alcohol and medicine containing strychnine. These two drugs form a fatal combination. Some cathartics and tonics contain strychnine.

As a Food.

Alcohol is a combustible substance, yielding approximately 7 calories per gram. Its food value is exclusively that of a fuel, to be burned with the release of energy. It has no food value for the upbuilding or repair of tissues. When it causes an increase of weight, it is because it spares fat food to some extent, and permits fat to be deposited in adipose tissues. As a food, it has no advantage over sugar.

As a Medicine.

As a medicine, alcohol is classed among the *narcotic* or sleep-producing drugs. It resembles in its action ether and chloroform, and had been used for similar purposes before the more powerful anesthetics were discovered about a hundred years ago. For most narcotic purposes, newer drugs have replaced alcohol to a considerable extent.

In the past, alcohol was used for its supposed warming effect when exposed to chilling. For some time it has been known that alcohol does not warm the body, but simply transfers some of the body heat from the interior to the surface. It dilates the small bloodvessels in the skin, where the temperature receptors are, and the body feels warm. But the interior is proportionately cooled. The effects actually predispose to more chilling if exposure continues. Alcohol taken after chilling has already occurred has the effect of a hot bath, but it lowers resistance to some infections such as might result from chilling. This is especially true of pneumonia. The death rate from pneumonia is especially high in alcoholics.

Also, in the past alcohol was used for its "bracing" effect. It is now known that it has no such effect, except of a very transitory nature. It is a narcotic, not a stimulant. When it appears to banish fatigue, the effect is due to lessened awareness of fatigue. In such circumstances, the false bracing might lead to carrying fatigue to a dangerous degree.

In June 1917, the American Medical Association passed the following resolution:

"Whereas we believe that the use of alcohol is detrimental to the human economy, and its use in therapeutics as a tonic or a stimulant has no scientific value; therefore, Be it resolved that the American Medical Association is opposed to the use of alcohol as a beverage; and

"Be it further resolved that the use of alcohol as a therapeutic agent should be further discouraged."

At about the same time, the British committee previously mentioned, made a somewhat similar report. Quoting again from the summary of its third edition: "Alcohol has no practical value as a direct stimulant of the heart in cases of threatened failure. When it appears to promote recovery from fainting, this is due to its irritant action on the mucous membrane of the mouth and is comparable to the action of smelling salts. When, in conditions of more protracted cardiac weakness, alcohol has a beneficial effect, this is due mainly to its mildly sedative action, relieving the centers which modify the action of the heart from the disturbing influence of pain and anxiety. The mildly narcotic action of alcohol is the most important effect from the therapeutic point of view. It may relieve distress and promote sleep; but it must be prescribed with care and judgment. During convalescence or in a chronic illness it may improve the appetite."

Chronic Alcoholism.

After often repeated doses over a considerable period of time, chronic alcohol poisoning is likely to occur. A person may become chronically poisoned without ever having been acutely intoxicated. One of the large mental hospitals, admitting hundreds of cases of mental disease due to alcohol every year, states that heavy drinking leading to true addiction most often began about ten years after the first use of alcohol.

A person is either already, or is likely to be, an alcoholic if he drinks every day, or if he has occasional bouts of drinking for days at a time.

Chronic alcoholism is a progressive disease as long as drinking continues. Its major manifestations at first are nervous irritability, mental instability, insomnia, headache, tremor of the hands, tongue and lips, and a change of personality. It precedes or complicates many other diseases.

Some of the symptoms found in the alcoholic appear not to be due to alcohol itself, but to habits common in the alcoholic. For

example, the diet may be so restricted as to give too little nourishment. Lack of vitamin B has been found often to be the cause of the motor nerve paralyses such as occur in alcoholism.

The most serious effect of chronic alcoholism is upon the mind. An alcoholic is subject at any time to acute mental symptoms, of which delirium tremens is the most familiar, or to a progressive deterioration of the mind, resulting in chronic mental disease. It has been reported that alcoholism is the cause of 10% of first admissions to mental hospitals.

Chronic alcoholism frequently causes death. For obvious reasons, the precise cause of death in such cases is not always stated. According to the United States Census Bureau, only three out of 1,000 deaths are ascribed to this cause. But alcoholism is mentioned as a secondary cause in three times as many cases, or in one death in every hundred. It is believed that it plays an important role in many cases when it is not mentioned in any way on the death certificate. Most deaths from alcoholism occur at middle age, and more frequently in men than in women.

According to statistical evidence from Raymond Pearl, moderate drinkers do not have appreciably shorter lives than total abstainers, but heavy drinkers do.

Cure of Alcoholism.

Sir William Osler, one of the greatest medical authorities, said, "Once fully established, the habit is rarely abandoned." Nevertheless, in some cases, if the habit can be abandoned, physical and mental rehabilitation is possible. It has been stated that if the individual is no more than 35 years old, in good physical health, and has been drinking for no more than seven years, the outlook is good.

Since the alcoholic usually cannot give up alcohol if it is at hand, institutional treatment is often necessary. The treatment consists of efforts toward physical normalization, and especially toward developing an attitude of mind that will make it possible to forego alcohol in the future.

Causes of Alcoholism.

Hereditary weakness of the nervous system seems to play some part in causing alcoholism. Such weakness may lead the members of a given family both to indulge freely in alcohol and to be more injured by it. Environment also plays a part, in that it may supply the influence of suggestion and opportunity. Physical conditions in the body seem to have little effect (so far as is known at present)

in predisposing to alcoholism; but states of mind are of great importance.

Most people first begin to drink because alcoholic beverages are at hand and others are drinking them. Thereafter, the chief factor that determines whether or not they become alcoholic appears to be their own personality make-up. One of the leading authorities believes that chronic alcoholism only develops in those of weak or unstable nervous system. It is this type of person who is least likely to be able to stand on his own feet and establish a genuine foundation for a sense of euphoria, and most likely to resort to alcohol for his mental support and satisfaction in life.

Often alcohol does not meet the need of the present situation, and yet gives a feeling that it has, thus preventing the use of constructive measures.

For example, the shy person, so inhibited that he cannot associate with others easily and naturally, may value alcohol highly as a means of making himself socially acceptable. Yet it may not have made him so; the release of his inhibitions may have gone just too far, and instead of being as brilliant and witty as he feels, he may appear to others merely excited or "silly." Second, if he is pleased with himself after drinking, he is less likely to take any constructive steps to develop a normal degree of social ease.

Since the euphoria created by alcohol is a false one, and at best transitory, it would seem sounder to establish genuine sources of euphoria. This, unfortunately, is beyond many people. But the person who can create a personality and a life situation that give satisfaction, who does not have to flee into a fairyland to make his dreams come true, is scarcely likely to fall a victim to alcoholism.

Alcohol as a Public Health Problem.

An editorial in the New England Journal of Medicine, July 13, 1939, states, "Tuberculosis, syphilis and alcohol are three of the major problems in public health. . . . The world is waking up to the fact that it is possible to do away with both tuberculosis and syphilis. The treatment of alcoholism as a public health problem has fallen far behind the other two."

In 1940 the Research Council on Problems of Alcohol, a group composed of eminent scientists, physicians, business men, educators and public health officials, began work with the announced objective "the cure and prevention of alcoholism and the alcoholic psychoses." In the same year Allied Youth, Inc. announced its interest in education regarding alcohol.

NARCOTICS

The term narcotic is commonly used to mean the opiates (opium derivatives) and drugs closely resembling them and having similar effects. (See list on page 296.) (Alcohol belongs in this group, but is usually considered separately since it involves somewhat different medical and legal problems.)

Although it had been used in oriental countries, opium was not widely used in western Europe until the nineteenth century. Morphine, the active principle of opium, was not discovered until 1815. It is now the most important drug for the relief of pain. Addicts of morphine and the various derivatives of it are estimated to number at least 100,000 in the United States.

In the addict, the most important effect of morphine is on the central nervous system. It depresses the brain, especially its higher functions. Sensory impressions are dulled, the imagination becomes free, and a pleasant, more or less apathetic state of mind appears.

The effect of the other derivatives of opium and also of the drug cocaine is somewhat similar.

Addiction to narcotics comes about most often in much the same sort of persons as becomes addicted to alcohol, and for much the same reasons. Knowing the nature of the drug they are taking, they yet hope to escape disastrous addiction. Kolb, of the United States Public Health Service, has stated "Comparatively few persons with normal nervous constitutions become addicted or remain addicted for long periods."

There should be no misunderstanding about the almost universal lack of ability to keep within reasonable limits or to avoid consequences if one uses these drugs at all. Virtually no one who uses them for any length of time escapes becoming addicted to them. Addiction comes after from ten days to five weeks of daily use.

Furthermore, scarcely any addict escapes the necessity for increasing the dose in order to obtain the same physical and mental gratification. Finally, very large doses have to be taken, the general health becomes poor, and the personality sinks to the level of seeking only the satisfaction of the craving, by fair means or foul. After addiction is established, the pleasurable effect of each dose wears off quickly, and is followed by weakness, depression, anxiety, and disagreeable physical symptoms such as nausea and abdominal pain. The addict will then do almost anything to get his drug.

As for the type of person most often addicted to narcotics, Pescor, of the United States Public Health Service Hospital at Lexington, Kentucky, states that the ages are chiefly between

twenty and thirty; that white persons predominate over colored in the ratio 10:1; and that the occupations are predominantly domestic and personal service, with many from professional life and but few from the unskilled trades. As for the reasons for addiction, the same hospital reports that addicts most often mentioned "curiosity." Investigations at this hospital proved that drug users show increased suggestibility, which gives weight to some of the addicts' claim that they were "influenced" by their associates. Often, however, addiction is not begun at all deliberately, but through a chance taking of a drug, in ignorance of its nature.

Illicit Sale.

The enactment of Federal legislation in 1916 to control the sale of narcotics took them off the open market, but underground channels were promptly devised by narcotic "bootleggers" for carrying on the trade in them. This is now one of the most widespread and insidious trades in the world. The exclusive interest of one of the committees of the League of Nations is that of checking it. The illicit drug trade in the United States is said to involve a billion dollars annually.

The methods of the traffic consist not only of smuggling drugs into countries where they are contraband, but also of subtle efforts to increase the demand for drugs. Procurers, who often could not possibly be suspected of being such, try in various ways to get people unknowingly to take a few doses of a drug, and to become dependent upon it before they know what it is. Epidemics of narcotic addiction have arisen even in high school boys and girls through medicine passed about by a schoolmate who was the innocent tool of a "dope ring."

Rehabilitation.

Drug addiction is curable, but ordinarily the user of narcotic drugs is helplessly shackled in so far as his own efforts will help him to become free from the habit. Hospital treatment is essential. Physical dependence on these narcotics quickly disappears when the drug is withheld. However, psychological dependence may persist and bring about relapse unless the mental state can be changed and new habit patterns established.

The United States Public Health Service conducts two hospitals for drug addicts. The Federal Narcotic Farm Hospital at Lexington, Kentucky, houses 1,048 addicts. It is intended primarily for federal prisoners who are drug addicts, but accepts some volunteers. At Fort Worth, Texas, is a $4,000,000 hospital, opened in 1938, chiefly for volunteers.

The Lexington hospital reports show that 30% of discharged patients remain well, and 30% relapse. In the remainder the results were unknown.

What the Federal hospitals aim to do for the addict is "to rehabilitate, to restore to health and train to be self-supporting." These hospitals are also contributing greatly to the scientific knowledge of drug addiction.

MARIHUANA

Marihuana is one of many names for cannabis, the active principle of the hemp plant. Cannabis is a narcotic drug seldom used in medicine, because its effects are not well understood nor predictable. Its use is largely in the form of cigarets, known by various names ("reefers," etc.). The drug is psychically habit forming—that is, its users like its mental effects.

Although marihuana has been used in this country scarcely more than ten years, it has a history dating back to antiquity. It is even mentioned in the sacred books of India, the Vedas. Homer referred to it as a drug that made men forget their homes and turned them into swine. The Oriental word for it is hashish. The Persian order of Assassins that terrorized their land in the 11th Century derived their name from the Arabic word hashishin, or eater of hashish. As *bhang*, it figures in many stories of the Arabian nights.

Addiction to marihuana is increasing in this country as addiction to other drugs decreases. It is estimated that there are at least 100,000 addicts, the majority between 18 and 20 years of age. Probably there are many more. A newspaper stated that New York police in two months destroyed 170 tons of hemp growing in New York city backyards and vacant lots where it had clearly been deliberately planted.

The League of Nations is investigating the use of marihuana throughout the world, as it is a serious problem in many, if not all, nations.

In the report of the Federal Department of State to the League of Nations Advisory Committee on Narcotics, the following statement occurs:

"Addiction to marihuana, which was formerly confined largely to the Middle West and the Southwest, appears to be spreading. It has now become a problem in the Southeastern and Northeastern parts of the United States. A disconcerting development in quite a number of states is found in the apparently increasing use of marihuana by the younger element in the larger cities."

Regarding the effects of marihuana, the same report stated: "Taken in sufficient quantities, marihuana produces an almost immediate lust, complete irresponsibility, and a tendency toward wilful violence. Those who are habitually accustomed to use cannabis frequently develop a delirious rage after its administration, during which they are temporarily, at least, irresponsible and liable to commit violent crimes. The prolonged use of this narcotic is said to produce mental deterioration and eventually insanity."

As one of its first effects, marihuana gives strange bodily feelings, as if the body had changed its size to very small or very large, or its weight, to that of a feather or that of a truck. Also it usually makes time seem either longer or shorter. Because of these peculiar sensations, often somewhat disturbing, its users seldom take it when alone, but chiefly when in the company of others at parties.

In this country, marihuana is contraband according to an Act of Congress establishing a marihuana excise tax law in 1937. This act makes the use of marihuana illegal, except by qualified persons, and brings the sale of marihuana under control of the Federal Bureau of Narcotics.

The sale of marihuana cigarets has not yet decreased, however. Formerly their high price gave a clue to the fact that they were not ordinary cigarets. To allay suspicion and increase trade, some dealers in them now sell them at ordinary prices. Anyone who offers them for sale may be prosecuted.

HYPNOTICS

Barbital and other derivatives of barbituric acid are powerful hypnotics which in many states may be purchased without a prescription, but which should not be thus purchased. Although somewhat less toxic than the opiates, they offer many serious dangers.

Barbital was introduced into this country from Europe in 1903. It won immediate favor among physicians as a substitute for opiates. Shortly it became even more popular among the public as a sleeping medicine. Within a short time it became evident that the drug is habit-forming, and that its sale should be restricted. In most European countries such restrictions have been passed. In this country, no nation-wide attempt has been made in that direction. Our present system of controlling the hypnotics, by labeling, is mentioned on page 296.

The effect of the hypnotics is not unlike that of the narcotics alcohol and opium. They dull the awareness of unpleasant bodily

and mental states, giving a moderate euphoria. Also, they lessen inhibitions, and impair judgment. Structurally, the barbiturates damage the nerve tissue of the brain—irreparably after long continued use.

Acute poisoning occurs from over-dosage, or by the presence of alcohol in the body at the same time. Chronic poisoning is the result of repeated doses. The higher brain centers may begin to be seriously affected in a comparatively short time if the individual develops no tolerance to the drug. The state of mind in chronic poisoning is often that of depression and suspicion. Violent outbursts occasionally occur, necessitating hospital care. After the drug is stopped, the mentality may not entirely return to normal.

Even the chemists who discovered some of these drugs are reported to be appalled at the misuse of the products of their skill. Dr. Mary M. Rising of the University of Chicago, who developed one of the important drugs of this series, has been quoted in the press as follows: "The present enormous sales indicate that persons who are wholly unaware of the harmful pathological effects of these drugs when used without a doctor's prescription are doing themselves serious injury."

TOBACCO

Tobacco smoke contains a number of chemicals, but its action is produced chiefly, if not entirely, by nicotine. In solution nicotine is a powerful poison. Death has occurred from absorption of 1.5 grams. A cigarette contains about one two-hundredth of that amount, but only a fraction of this is absorbed even in inhaling. Chronic nicotine poisoning from smoking does, however, occur. It may occur after a number of years in those who have smoked moderately, but is more likely in those who have not kept within bounds.

Statistical Evidence.

A recent statistical investigation suggests that further study of the physiological effects of tobacco are needed. In 1938 Raymond Pearl, of Johns Hopkins University, reported on the length of life in relation to use of tobacco. From the records of over 6,000 white males he found that "smoking is associated with a definite impairment of longevity." The shortening of life was in proportion to the amount of tobacco usage. His findings are tabulated in Fig. 68. Later, he reported on 300,000 individuals—100,000 each of heavy smokers, moderate smokers and non-smokers. At the age of sixty, 66,564 of

the 100,000 non-smokers were still living; 61,911 of the moderate smokers, and only 46,266 of the heavy smokers.

This report, being a statistical one, and concerned only with length of life, gives no evidence of the nature of the damage assumed by Dr. Pearl to have taken place in the smokers. Toxicologists list an

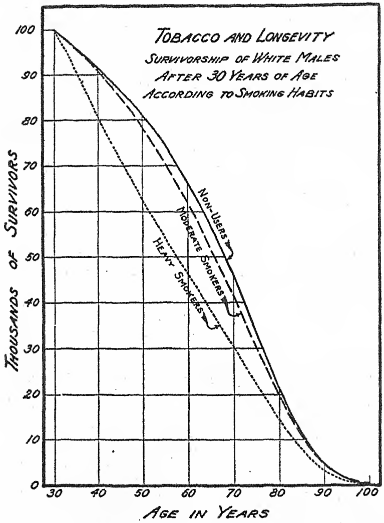

FIG. 68.—The survivorship lines of life tables for white males falling into three categories relatives to the usage of tobacco. A. Non-users (solid line); B. Moderate smokers (dash line); C. Heavy smokers (dot line). (Science, March 4, 1938.)

imposing array of poisonous effects of nicotine, and it may be supposed that in the individuals whose lives were apparently shortened by its use one or more of these effects was either a primary or a contributory cause.

Toxic Effects of Nicotine.

The action of nicotine is chiefly upon the nervous system, both the cerebral centers and the nerves. There occurs first a very brief stimulation followed by depression. Through the nerves,

tobacco acts on the functions of many parts of the body. When taken in tobacco smoke, the main effects are upon the nerves, the circulatory system, and the digestive system.

Effect on the Nervous System.

In moderate doses, tobacco appears to exert a stabilizing effect on nervous equilibrium. It induces a temporary state of calm and repose, with obscuring of the sense of fatigue and discomfort. In heavier doses, it may increase nervous excitability. Also, it may do so in habitual users in the intervals between smoking. It appears that those who are of a nervous temperament are most likely to feel the need of the "soothing" effect of tobacco, to repeat the dose more and more frequently, and eventually to show a more or less perpetual nervous irritability.

As for the effect on mental performance, tests have given contradictory results. Most tests of the young have shown a poorer performance for smokers than non-smokers. In an habitual smoker subject to nervous tension when deprived of tobacco, the relaxation after smoking may make possible a better mental performance than before smoking, the improvement lasting a few moments, until the irritability returns. On the other hand, those who have become chronically poisoned often show general slowing and lack of energy in mental work.

Various other manifestations of the toxic effect of tobacco on the nervous system have been noted. For example, some individuals experience enough neuromuscular incoordination in the small muscles of the hands to make their hands unsteady for fine work. In others, the eye muscles may be similarly involved. Vision itself may be impaired. Tobacco blindness is, however, rare, occurring almost exclusively in those who also use alcohol to excess.

Effect upon the Heart.

It has long been known that tobacco has a tendency to disturb the function of the heart. When pronounced, such functional disturbance gives a condition known as tobacco heart. Although it involves no organic changes in the heart, it does lessen the ability of the heart to bear up under strain of any sort, including exertion and illness. There is also the possibility that continued poor function might in time do structural damage. In a given case, whether or not tobacco is harmful to the heart depends upon the individual's condition, and that can only be determined by his physician.

In all persons, smoking causes the heart to beat more rapidly. Any increase in heart rate may in time weary the heart, by lessening

the amount of rest between beats. In an individual with an already weak heart this might be injurious.

Also, in all persons, the "wind" is reduced after smoking. Athletes and physical trainers as well as physicians have noticed this fact. During regular athletic training, the use of tobacco is usually prohibited on that account. Experimentally it has been shown that in a cross country run open to smokers and non-smokers, there are more smokers in the last ten than in the first.

The first evidence of chronic nicotine poisoning may be a definite tendency to breathlessness on exertion and a pulse continuously rapid during the waking hours except upon first arising in the morning. Irregularity in rate may also occur.

Effect upon Blood Vessels.

The effect of tobacco upon the blood vessels is that of constriction. Such constriction throughout the body raises blood pressure temporarily, especially in those whose blood pressure is already high. If smoking were continuous, the blood pressure would be kept constantly elevated, and might produce the same organic effects as high blood pressure from other causes. If disease of the arteries were present, even temporary increases of blood pressure might contribute to their rupture.

It appears that tobacco has a more marked effect in raising blood pressure in those with especially sensitive blood vessel responses, and that some individuals may be especially susceptible to this effect from tobacco. Herrel, of the Mayo Clinic, demonstrated photographically that in some people even the small arteries in the retina of the eye contract in spasm after tobacco smoke has been inhaled. In these persons the blood pressure was often greatly increased immediately after smoking, and returned to normal in intervals between smoking. He attributes this effect to an idiosyncrasy to tobacco, because it is similar to that experienced by the normal person except that it is exaggerated in degree. To those having this idiosyncrasy, the use of tobacco would be a danger.

The same effect—constriction of blood vessels—can also be demonstrated by special apparatus to measure skin temperature of the fingers and toes, which drops from 1–1½° C. after smoking. In those with arterial disease of the lower extremities, this degree of constriction repeated might harmfully impede circulation, even to the extent of occluding vessels and causing gangrene. Haggard and Greenberg of Yale believe the effect upon the blood vessels comes

about through the action of nicotine upon sympathetic nerves, these in turn affecting the adrenal glands.

One of the symptoms of excessive smoking is pain under the sternum. It is not known whether or not this pain indicates constriction of blood vessels of the heart, but in any case it should be investigated. The great increase in deaths from blood vessel disease has coincided with the great increase in the use of tobacco, and some authorities believe that there may be some connection between the two.

Effect upon the Digestive Tract.

Most people are made ill the first time they smoke, and some continue to be susceptible to the same symptoms from tobacco. The effects are partly local, through swallowing nicotine-laden saliva, but for the most part they appear to be due to disturbance of the sympathetic nervous system by nicotine that has been absorbed from mouth or lungs. The symptoms are those of mild or even marked indigestion. Physicians often find that a tendency to "indigestion" cannot be overcome until the use of tobacco is curtailed, or stopped. In those with stomach ulcer the lesion usually cannot be healed or kept healed if the patient continues to smoke.

Local Effects.

In some, the effect of tobacco smoke is irritating to the tissues of the mouth, eyes, and air passages. Again, the effect appears to be that of constriction of blood vessels. These membranes are usually somewhat dried, and thereby may be made more subject to other irritants. Various lesions in the mouth are more common in smokers (e.g. one type of receding gums). It is thought that certain white spots, called leukoplakia, are often due to smoking. These have been known to become malignant. Statistically, however, there is little evidence that cancer of the mouth, tongue, lips or upper air passages is more common in smokers than in non-smokers.

The situation may be somewhat different in regard to the lungs. There has been a marked increase in lung cancer, especially in younger people, and in the female sex. This increase has paralleled the increased general use of tobacco and the particular increase of its use by women. That there is some correlation between these facts is strongly suggested.

Conclusions.

"Tobacco is good for nothing but to entertain idlers" according to Napoleon Bonaparte. Probably most smokers would agree to

that statement if the last word had been omitted. Most of those who smoke do not defend the habit very strongly. Although enjoying its calming effect, most of them appear to feel that they "would be better off without it." Also, most smokers recognize that they are in bondage to tobacco, and would rather be free.

Since tobacco even in the well serves no important purpose and may do harm; since it tends to become a compelling habit; since it may cause chronic poisoning; and since, in some states of health even its moderate use is not permitted—apparently it would be discreet not to begin using tobacco, or, having begun, to cease.

A thousand ways to stop smoking have been suggested. But none except an effort of the will seems effective. In the absence of will power to make a clean break, the alternative seems to be the taking of one less cigarette a day until none are taken.

If one prefers to continue smoking, the habit should be kept under control so that it could be stopped easily if health required it. Some accomplish this control by not smoking one day a week, and one week every few months; or by smoking only immediately after meals.

Certainly in any case, the amount of smoking should be kept within the limits where symptoms of its toxic action appear.

As a rule, the bad effects of tobacco are functional and not organic. Symptoms due to tobacco usually subside after one stops smoking. That lasting harm may have been done in the meantime is a possibility in view of Pearl's statistical report, but, in the light of current clinical knowledge, is not a probability for the moderate smoker.

Chapter 12

DISORDERS OF INTERNAL ORIGIN

The disorders arising primarily from external agents (bacteria, physical forces, and chemicals) having been discussed, there remain to be discussed those conditions that spring largely from causes originating within. The qualifying term *largely* is necessary because in many of the conditions to be named bacteria, injury or poisoning may play a part. It will be recalled that a similar qualification was necessary in reference to the disorders of external origin. It appears that any disorder of health is an interaction between the self and the environment, and that the division between internal and external causes is largely an artificial one (see page 80). However, the distinction serves a useful purpose, especially in connection with the diseases to be mentioned in this chapter, because it calls attention to the point where preventive efforts must center—in the self.

This group of disorders of internal origin is numerically and in all other ways more important than any other group.

Among those that cause death, the following are at the top of the list.*

Cause of death	*Deaths per 100,000*
Heart Disease (90–95)†	268.0
Cancer and other malignant tumors (45–53)	112.0
Diseases of the arteries (cerebral hemorrhage, arteriosclerosis, and high blood pressure) (82, 97, 102)	104.4
Nephritis, acute and chronic (130–132)	79.5
Malformations and diseases of early infancy (157–161)	49.0
Diabetes (59)	23.7
Appendicitis (121)	11.9
Hernia, intestinal obstruction (122)	10.1
Cirrhosis of the liver (124)	8.5
Puerperal causes (associated with childbirth) (140–150)	8.3

FIG. 69.

* *Vital Statistics Special Reports, Vol.* 7, *No.* 24, *pp.* 77–90.

† *The small figures refer to the official list of diseases.*

This list includes the two diseases (heart disease and cancer) that today are the largest single causes of death. No diseases of external origin except influenza, pneumonia and tuberculosis have as high a death rate as the lowest on this list. Accidents, however, rank about the same as the fourth (nephritis).

Five diseases on this list will be discussed in this chapter: *cancer*, *diabetes*, *appendicitis*, *hernia and intestinal obstruction*, and *cirrhosis of the liver*. The others will be discussed elsewhere.

Another list might be given of diseases chiefly of internal origin that are not so often fatal but are important for the disability and suffering they cause. Many of these are mentioned in other chapters. There remain to be discussed here: *rheumatic diseases*, *ulcer of the stomach and duodenum; gall bladder disease; asthma and other allergic diseases;* and the *endocrine disorders*.

CANCER

The body is characterized by orderly growth of cells from the moment of conception onward. The rate is very rapid at first, and gradually becomes slower until, in adult life, whatever cell growth takes place in replacement of lost cells, takes place at a very slow rate. Furthermore, the normal growth of cells is orderly and serves useful purposes in the body.

In contrast to this slow, orderly growth, the cancer is a local center of rapid, disorderly growth. The rate of growth may be as rapid as in the early days of intrauterine life. But the growth of cancer cells is a wild growth, serving no useful purpose whatever—indeed serving only for destruction. The term malignant (acting maliciously) is applied to these local new growths, because they are invariably fatal if their growth continues. Even if they remain local they harm the body, first, by consuming so much nutriment that the rest of the body becomes malnourished and wastes away. Second, they destroy the tissue in which they are growing, and from the area are given off toxins seriously harmful to the body.

Many cancers do not remain confined to the area where they start. They spread in two ways. First, by direct extension they may invade and destroy nearby tissue. Second, they may spread by metastasis (standing after). By this process, a local cancer may implant itself in remote tissues. Metastasis takes place when cancer cells from a local area are carried away from that area. They may enter the lymph vessels and travel to lymph nodes along their route (e.g. from the breast to the lymph nodes under the arm); or the blood vessels, and travel to remote organs (e.g. from intestine to liver).

In spite of the fact that much is known about the cause of cancer, and that two methods of treatment are available, cancer has risen from seventh place to second place among the causes of death in this country in the past 25 years. Many of the 150,000 cancer deaths each year in this country are entirely unnecessary.

To reduce the death rate from cancer two things may be done. First, prevent cancer from starting. Second, prevent cancer from progressing to a fatal termination. Science has much to say on both these points.

The most effective method of preventing cancer is based upon definite knowledge that cancer often appears in an area that has long been irritated. Any chronic

irritation—by mechanical agents (such as friction), or by chemical agents (there are 50 chemicals that produce cancer in laboratory animals), or by physical agents (such as sunlight) definitely predispose an area to the disorderly local growth of tissue known as cancer. To prevent cancer, attention must be focused upon preventing any and all chronic irritations of any and all parts of the body.

One of the foremost authorities on cancer, Dr. Clarence C. Little, has formulated the following rules for avoiding irritation such as might lead to cancer.*

> "*Mouth, Lip, and Tongue.*—Follow the well-known habits of oral hygiene, keeping teeth, gums, tongue, and mouth clean. Exercise proper dental care, having the dentist correct any jagged teeth or ill-fitting plate that might chafe or exert pressure on the tongue, the inside of the mouth, or the gums.
>
> *Throat.*—Avoid eating too hot food.
>
> *Stomach.*—Avoid food or drink that causes any digestive distress. The exact procedure to be followed in this case will naturally vary with the individual.
>
> *Intestine and Rectum.*—Establish habits of bowel regularity. Do not allow hemorrhoids (piles) to continue without being corrected.
>
> *Breasts.*—Avoid confining, chafing, or irritating clothing, brassieres, or corsets.
>
> *Uterus.*—See to it that any injuries or tears received during childbirth have prompt and adequate medical or surgical treatment.
>
> *Skin.*—Keep the skin clean and protected from too much exposure to sun and wind."

Many cancers can be prevented by the most meticulous care to avoid chronic irritations, but not all. Attention must therefore be focussed upon detecting a beginning cancer while it is still local, and can be completely removed.

There should be no deaths whatever from cancers on or just under the surface of the body—and the largest proportion of cancers are in such locations. When cancer arises in the interior of the body, it can only be suspected by disorders of body functions.

If every abnormality that can be seen or felt, and any abnormality in the various functions of the body were promptly investigated, a large number of cancers could be discovered in their early, local, and relatively curable, stage.

Man's tendency is to make light of minor maladies, or treat them himself, or on the other hand to do nothing but worry about them, fearing the worst. Neither attitude is appropriate. Certainly there is no need or room for worry about this or any other disease. The normal, healthy, sensible procedure is to recognize abnormalities, have them attended to, and forget about them.

Dr. Little recommends that one consult a doctor particularly for any of the following symptoms:

> "*Mouth, Lip, and Tongue.*—Any sore that does not heal within ten days to two weeks. Any lump or local thickening. On the tongue persistent white areas, especially in the case of smokers.

* *From "The Fight on Cancer" by Clarence C. Little, Sc. D., Managing Director of the American Society for the Control of Cancer, Inc., and Director of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine. Public Affairs Committee, Incorporated.* 1939.

Throat.—Difficulty in swallowing or hoarseness lasting for more than two weeks, which cannot be explained by a cold or other direct cause.

Stomach and Intestine.—Distress following eating, especially in those of middle age or older who have not been previously aware of such a condition. Sudden or marked loss of weight without any recognized cause. Distaste for meat. Alternate periods of constipation and diarrhea with no particular change in diet to account for it. In the case of the lower intestine or rectum, the appearance of blood as a rectal discharge or in the stools.

Breast.—Any lump, lack of symmetry, persistent soreness of the breast, or colored discharge from the nipple.

Uterus.—Any irregular bleeding at any time during life.

Skin.—Any lump, or sore that does not heal in ten days to two weeks. Any mole, wart, or wen which develops tenderness, changes its texture, or begins to grow.

Many of these conditions will turn out not to be cancer."

To this list might be added pain. It is not often an early symptom of cancer, but always merits investigation.

The majority of cancers appear in those over forty, but even in the 15–19 year period, cancer is among the ten leading causes of death in the United States and Canada. The type known as sarcoma is especially common in youth. Cancer becomes the leading cause of death for white women at the age of 35.

There are several popular misconceptions about the cause of cancer. For example, in a recent "poll" of the population it was found that one person in five believes cancer is "catching," and another one in five is not sure. The other three in five were right—cancer is definitely not a communicable disease.

A still more absurd notion is that certain articles of food—milk, or tomatoes, or some other valuable food—causes cancer.

As for the effect of a single blow—on the breast, for example—if cancer ever arises from such a cause it is certainly extremely seldom.

Regarding heredity, it may be stated that cancer has been proved to be hereditary in mice, but in humans no specific hereditary factor that leads to cancer has been found.

The diagnosis of cancer is made by a preliminary examination, aided, in the case of the interior of the body, by the views obtainable by use of the fluoroscope and X-ray photographs. The final diagnosis is made by the microscopic examination of a bit of the tissue (biopsy) by a trained pathologist.

There are two forms of treatment for cancer, and only two. They are surgery and radiation. Radiation is by X-rays or by radium. New powerful machines for radiation have recently been discovered (e.g. the cyclotron) from which even greater benefits are expected.

Surgery and radiation may be used separately or combined. The choice of treatment is determined by the surgeon on the basis of location and type of cancer and various other factors, according to his judgment.

A fairly high percentage of cures are complete. One large hospital reports cures in 87% of early breast cancers.

Fake cancer cures by the hundred are offered to the gullible public, and purchased by many, who discover their mistake too late to save their lives by scientific methods. Testimonials of those who have been "cured" have no value. If they were cured of anything, it was not cancer.

Research regarding cancer is being carried on by many organizations. The federal Government has a National Cancer Advisory Council, and a National Cancer Institute conducted by the United States Public Health Service at Bethesda, Maryland. Several states have cancer divisions in the departments of health. In Massachusetts, several hospitals and clinics are conducted under the state department of health. All these are concerned in reducing the death rate from cancer, by research, by cure, and by education of the public in prevention.

Research is also carried on by many private organizations such as medical schools and hospitals, and by the American Association for Cancer Research. Although cancer research has been endowed by several philanthropists, it is relatively not so well financed as its importance requires.

Because the prevention and cure of cancer is so largely a problem for the individual, one organization, the American Society for the Control of Cancer, has for years been devoting itself to education of the public regarding the disease. Recently it has created the Women's Field Army, in which 135,000 women are actively interested.

DIABETES

The term diabetes means literally "going through." It is applied to a disease in which sugar "goes through" the kidneys, and appears in the urine. This is not the whole story of diabetes, nor is diabetes the only condition in which sugar appears in the urine. The diagnosis of diabetes rests also upon the finding of a high percentage of sugar in the blood, and upon numerous clinical signs and symptoms.

The disease diabetes is due to a disorder of certain cells in the pancreas, which occur in groups known as the islands of Langerhans (named after the great pathologist who first described them in 1875).

These cells in the pancreas manufacture a substance called insulin, which is necessary for the storage and combustion of carbohydrates. If not enough insulin is produced, blood sugar increases, and some of the excess sugar is discharged through the kidneys.

The role of insulin is to activate carbohydrate metabolism. It increases the rate at which sugar is utilized and stored. Without enough insulin, the rate is too slow for health and comfort.

Before 1922, diabetes meant invalidism and death. In that year Banting and Best, in the laboratories at the University of Toronto, succeeded in producing insulin, which may be administered by injection to those who lack it.

The result is that diabetics may now live a practically normal life if they carefully follow the necessary treatment. Young men with diabetes may even play on major teams in colleges. Women can go through childbirth in comparative safety. Surgical operations, formerly very hazardous for diabetics, are now feasible.

Expectation of life for diabetics has greatly increased. An adult of forty can now expect to reach the age of 60, instead of 47, as in the days before insulin. A child diabetic has a proportionately good outlook.

Yet the fact is that there are now more diabetics than ever before, and that the actual number of those who die of it is greater. In 1939 there were probably nearly half a million cases of diabetes, and two million people living, destined to develop it. Part of the increased number of cases is due to more frequent recognition of the disease by physicians; and part of the increased number of deaths is that this is a disease which develops more often after 40, and that now more people live to that age than formerly.

Nevertheless, it is thought that there actually is more diabetes, and that the reason for it has to do with our modern manner of living. The diasese is more common among the well-to-do, the well-fed, and the little-exercised. A considerable proportion of cases are among urban dwellers, and especially among women. These factors are considered of importance in bringing on the disease, especially in those with an hereditary predisposition to it.

It is generally agreed that a predisposition to diabetes is hereditary—that is, that many people are born with a latent insufficiency of the regulatory mechanism for carbohydrate metabolism. Whether this functional incapacity in a given case will ever become the actual disease diabetes, is another question.

The predisposition to diabetes seems to be a simple recessive characteristic, transmitted according to the Mendelian ratio (see Chap. 44). The results of mating will be as follows:

a. Two diabetics; all the children may have the disease, and one third may develop it before 40.

b. One diabetic, and one carrier (not a diabetic, but with diabetic heredity); half the children may be diabetic.

c. Two carriers; one fourth the children may be diabetic.

d. One diabetic, and one having neither diabetes nor a diabetic heredity; none of the children need be diabetic, but all will carry the diabetic trait.

The question arises, should the diabetics, or those with a diabetic inheritance, marry? Two points are of interest in this connection. First, there are probably 30,000,000 people in this country with a diabetic inheritance, and it would be rather difficult to follow genetic principles so strictly as to be sure of not having diabetic children. Second, it is thought that even those with a diabetic inheritance need not have the disease if due preventive measures are used. And it might also be added, that even those who know of no diabetes in their family tree are not necessarily "immune" to the disease, as it may have been latent in the family. Finally, even if a person were certain of no diabetic inheritance, there is no guarantee that he will not develop it as an acquired disease.

Obviously, the important thing is to know what conditions may cause diabetes to appear, whether one belongs to a diabetic family or not, and to regulate life so that it will not appear.

The foremost measure to prevent diabetes is to keep the weight down to normal. Those who are 26% overweight have a mortality from diabetes ten times that of those who are of normal weight. The control of weight should be by means of diet, with special care not to take too much fatty food. A moderate amount of carbohydrate must be included in the diet, even in the case of those with diabetic tendency. As in every diet, due care should be given to providing vitamins. The value of exercise in promoting carbohydrate metabolism is unquestioned, both in the prevention and the treatment of diabetes.

Among the first symptoms of diabetes are great thirst and hunger, and copious urination. Such symptoms should send a person to a doctor. The treatment, if diabetes is diagnosed, is a diet supplying exactly the amount of carbohydrate that the individual requires, and exercise and other individually chosen measures of hygiene. Insulin is often used also, but sometimes the disease can be controlled without it.

In any case, the diabetic must be under close medical supervision. Many hospitals have diabetic schools for training the patient to do certain things for himself (e.g. measure his food, test the urine, care for the skin, etc.). An examina-

tion, covering 127 questions, is given to the diabetics in one of the clinics, and he must know the answers to all of them before he is trusted with daily care of himself outside the hospital.

Diabetics as a group are persons of superior physical and mental quality. Perhaps because of the care they must take of themselves, and the constant medical supervision, they are often comparatively free of certain other diseases. Even the disease itself does not necessarily incapacitate them at all, or shorten their lives. According to a recent report, 90% of a large group who began to have diabetes while under 40 years of age, and were still under 40, were leading a normal life. And of those past 40, 76% were leading a normal life. Clemenceau, the great French statesman, lived to be 88, with diabetes that hampered his career very little.

Diabetes is not the dread disease it formerly was, but it is obviously one that should be avoided if possible, and that very often may be avoided, in spite of its hereditary element.

APPENDICITIS

It reflects upon the intelligence of the people of the U.S. that we should until 1939 have had the highest death rate from appendicitis of any of the civilized countries, and that even in 1939 should still be tied for second place on the lists.

Each year, the appendix is removed from about 300,000 people in this country. About 280,000 of these people recover, but about 20,000 of them do not. Actually, practically all of them should recover.

Appendicitis by itself is seldom a fatal disease, and the surgical operation for it is a simple one. When appendicitis causes death it is almost always because of complications that need not have arisen if the person with a "stomach ache" had done the right thing, and had not done the wrong thing.

The *right* thing to do is to have a doctor for any abdominal pains or cramps that last more than 4 hours; and *the wrong thing to do is to take a cathartic* in such circumstances. Abdominal pains of four hours duration usually mean something serious—perhaps appendicitis, perhaps something else, but in any case something needing treatment. And it makes no difference where the pain is located. Often people think that a pain cannot be appendicitis because it is not on the right side. The pain of appendicitis may be all over the abdomen at first. It seems particularly likely to occur in the region of the navel. With it, there may be nausea, belching. and vomiting, which may suggest ordinary acute indigestion. Usually the pain is somewhat crampy, rather than a steady ache, although even this is not invariable,

Inflammation of the Appendix.

The pain in appendicitis is due to inflammation and swelling of the appendix, and partial or complete obstruction of its opening. The crampy character of the pain is due to peristaltic contraction of the intestines and of the appendix itself.

The vermiform (worm-like) appendix is a vestigial organ—that is, one that formerly may have had a function, but is functionless now. It is a tubular sac, usually about 3 inches long, which arises from the intestine in the region of the cecum (see Fig. 39).

When it becomes inflamed it is because fecal material or bacteria enter it. Probably fecal material frequently enters, but is promptly extruded. In some cases, such material remains and becomes dry and hard, forming fecoliths (fecal stones). These are often found in removed appendices. Irritation from them is probably one of the causes of appendicitis; and the effort of the appendix to expel them may be a cause of the colicky pain when appendicitis first starts.

Bacteria from the large intestine have free access to the appendix, and may easily inflame it. So also may bacteria brought there through the bloodstream from other parts of the body.

It is thought that seeds of fruit may cause appendicitis, but certainly much less often than other causes. Most of the seed-like substances found in the appendix prove to be fecoliths.

Inflammation of the appendix may be of any degree, up to the formation of an abscess involving the whole structure.

Inflammation of the Peritoneum.

When the appendix is inflamed, the peritoneum around it and in its vicinity becomes more or less inflamed also. This is called peritonitis. It ranges in degree from a mild local inflammation to a severe inflammation of the entire lining of the abdominal cavity and the coverings of other abdominal organs. It is the spreading type of peritonitis that is chiefly responsible for causing death from appendicitis.

The total area of the peritoneum is about the same as that of the skin. Just as inflammation of a large area of the skin, as from burns, is fatal, so also is inflammation of a large area of the peritoneum. Spreading peritonitis seldom occurs except when the pain of appendicitis is ignored or treated by cathartics.

Delayed Treatment and Spreading Peritonitis.

Infection of the whole peritoneum is most likely in circumstances when the appendix forms an abscess and the abscess ruptures, discharging pus into the abdomen. Until the year 1887, there was no way of preventing the many deaths that occurred from this cause. In fact it was not recognized that the appendix caused peritonitis until that fact was discovered by Dr. Reginald Fitz of Boston. He was the first to remove a diseased appendix. Since then, physicians have known that an infected appendix must, if possible, be removed *before it has ruptured.*

The chances of recovery from appendicitis are many times as good if operation is done on the first day as on the second; and become less good for every day of delay. In one city in which there was an average delay of 91.2 hours between the time that symptoms appeared and operation was performed, the mortality was 30 per 100,000. In another city, with only 49 hours of delay, the mortality was only 11 per 100,000.

Delay in having medical advice is seldom excusable. In adults, appendicitis does not usually spring up over night, nor in a few hours. Usually there has been evidence of trouble brewing for some time before an abscess forms.

The diagnosis of appendicitis is usually made by palpation of the abdomen, and detecting an inflamed and tender appendix. Sometimes it is useful to know how many white cells are in the blood, as a guide to the severity of the infection. Various other tests may be needed at times (e.g. X-ray, urinalysis, etc.) to rule out other possible conditions. No medicine will be given to stop the pain until it has served its purpose as an aid to diagnosis.

Cathartics and Spreading Peritonitis.

Cathartics cause peritonitis to spread because they stir up active motion in the intestinal tract at a time when it needs quiet in order to "wall off" the infected area. Many a peritonitis would remain entirely local, and relatively harmless, if the area were kept quiet.

The process of "walling off" consists of the growth of fibrous tissue attaching the inflamed surfaces to each other in such a way as to act as a mechanical barrier to

the spread of infection. Even in the case of an abscess, if it has not been unduly stirred up, it may be neatly walled off, so that no spread of peritonitis takes place.

The fatality rate for spreading appendicitis is 1:4. For a walled off appendix, the fatality rate may not be more than 1:200. Hippocrates, 400 B.C., although he did not know why it was so, noted that it was unsafe to give laxatives to those with sharp abdominal pain.

In one series of cases 1:19 of those who had taken one dose of laxative died of spreading peritonitis complicating appendicitis, and 1:9 who had taken more than one dose. Only 1:62 who had not taken a laxative, but had delayed having medical care, died. Physicians wish that every one familiar with the three R's were equally familiar with the three P's indicating the dangers in appendicitis—Purgatives, Perforation, Peritonitis.

In order to keep the intestinal tract absolutely quiet when the appendix is inflamed, it is essential not to eat or to drink anything while having abdominal pains suggesting appendicitis.

Chronic Appendicitis.

Many cases of acute appendicitis do subside, at least for the time being. But the appendix may not entirely heal, and the trouble may recur. The term chronic appendicitis is often used to describe the condition of an appendix that has been inflamed, and is still mildly so. Usually there will be adhesions around such an appendix, and these may be the cause of continued pain and perhaps of interference with the action of the digestive tract. Also, a chronic appendix may again become an acute one, possibly as the result of acute inflammation elsewhere in the body, or from numerous other causes within the abdomen (e.g. pregnancy). For these reasons, if it is determined definitely that the appendix has once been the site of acute inflammation, and is still inflamed, it is often considered safer to remove it.

Causes of Appendicitis.

To prevent death from appendicitis it is essential to avoid delay and self-treatment. Methods of preventing the disease from arising cannot be stated so definitely. It is generally agreed that good habits of eating and good bowel habits are important in preventing the appendix from becoming inflamed. By causing the fecal material to be too watery, cathartics may, however, do more harm than constipation. In general, any disturbance of the digestive tract should be set right as soon as possible, according to the advice of a physician. In some cases, lack of muscle tone in the digestive tract may be responsible for appendicitis through preventing the appendix from expelling any foreign material that enters it. In children, frequently a parasite called "pin worm" is found in removed appendices. Finally, since the appendix may become infected from infection elsewhere in the body, the aim should be to prevent all such infections, or have them promptly cured.

Campaigns against Appendicitis.

Recently there has been a nation-wide campaign stressing the danger of delay and of cathartics in cases of abdominal pain. The result is that the decrease in our national death rate from appendicitis during the five years 1934–39 has been greater than in any other country. In some states (e.g. Pennsylvania and New Jersey) special efforts have been made among school children, to warn them of these dangers, because nearly 40% of the cases of appendicitis occur in the second

decade of life. At least 75% of cases occur under the age of 30. Some cities, too, have shown a great improvement in appendicitis mortality as a result of information given directly to those most susceptible, and hundreds of lives have been saved.

HERNIA AND INTESTINAL OBSTRUCTION

Hernia, popularly known as "rupture," was fully defined by Celsus about 100 A.D., as "a protrusion of a loop or knuckle of an organ or a tissue through an abnormal opening."

The abnormal opening may be merely a natural opening that for some reason is wider than normal. The commonest hernias are those that pass through the inguinal canal in the groin, which normally carries the spermatic cord in the male and the round ligament of the uterus in the female. Next in frequency are the hernias that pass through the femoral canal (also near the groin) which carries the femoral blood vessels to the leg. The space through which these structures pass may be congenitally wider than normal, in which case even moderate strain, such as hard coughing, or lifting, may create enough pressure from within the abdomen to cause part of the intestine to protrude.

A hernia is called reducible when the protruded part slips back of its own accord when the patient lies down, or can be pushed back by gentle pressure. In some cases a bandage or a truss will hold it there. Such treatment has been in use since 3000 B.C., and is still in use. More often a surgical operation, to narrow the opening, is the best form of treatment. This too, is an old form of treatment, dating back to before the Christian era.

A more recent form of treatment consists of injection of drugs around the opening, to cause it to close more firmly. This method is sometimes useful when neither a truss nor an operation is feasible.

The danger of a hernia is that the protruded part of the intestine will become strangulated—that is, pinched in such a way as to obstruct* it and shut off its blood supply. Such a condition is very serious, and requires immediate operation if life is to be saved.

In its widest sense, the term hernia applies to the protrusion of any organ or part of an organ through the wall of the cavity where it belongs. This may occur, for example, through the diaphragm, owing to a congenital weak spot in its musculature. Sometimes the whole stomach will slide up into the thorax. Although not particularly rare, such cases sometimes cause front-page newspaper comment as "upside down stomach."

Occasionally, a hernia occurs through the umbilicus (navel), or through an abdominal scar. The latter may take place, for example, after an appendix operation, if the abdominal muscles are strained before the scar has become firm. These are called ventral hernias, and present the same dangers as any others.

A person who has a lump on the abdominal wall, or in the groin, or the scrotum, whether the lump is painful or not, should be examined. Most hernias come and go; they should be treated so that they do not come.

CIRRHOSIS OF THE LIVER

The term cirrhosis is derived from the Greek for *yellow*. It originally had reference to the yellowish color of the liver in this disease. Now it is understood to mean

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* *Intestinal obstruction may occur from other causes (e.g. narrowing or constriction from lesions of walls, blocking within, twisting, kinking, telescoping, or pressure from adjacent organs). Ordinary constipation, apart from disease, seldom causes obstruction, especially in the young.*

a condition in which the normal liver cells undergo fibrosis—that is, are replaced by fibrous, and consequently inactive, tissue. Such a condition may be due to obstruction of the bile ducts in the liver, or to other causes.

Most authorities agree that liver cirrhosis occurs especially in those who have taken distilled liquors regularly and freely. It afflicts men more often than women, and usually in the fifth decade of life. It may be present without giving symptoms, but often it is the cause of sickness and death within a few years after its onset.

RHEUMATISM

The condition popularly known as rheumatism is chiefly chronic arthritis, or joint inflammation. Other structures near joints may also be affected so as to cause similar crippling.

The amount of rheumatism in the United States is appallingly large. The National Health Survey showed that it is first in prevalence, second in producing disability, second in producing invalidism (permanent disability), and fourteenth in mortality in the United States. Only mental disease exceeds it in producing disability. Although heart disease is first in mortality, there are only half as many people ill with it as with rheumatism.

A large insurance company reports that arthritis is responsible for 9% of all cases of illness among its millions of policy holders, and that it costs its victims $200,000,000 in lost earnings in a year, representing 7½ million weeks of lost time. In Massachusetts more people suffer from rheumatism than from heart disease, tuberculosis and cancer combined.

At the present time, the medical profession is more hopeful in regard to its prevention and treatment, and public health organizations are therefore embarking upon arthritis programs. Rheumatism is being investigated in 27 hospitals of the United States Public Health Service, and by many state departments of health, and in many clinics and hospitals for the crippled.

Chronic arthritis is an ancient disease. Typical arthritis of the spine has been found by anthropologists in 40% of the skeletons of Egyptians who lived before the dynastic era.

Rheumatoid Arthritis.

The most crippling sort of arthritis is that which begins before the age of 40, especially in those who are "run down" by overwork or poor nutrition or chronic infections. It is a systemic disease with joint manifestations, and its prevention and cure depend upon the care of the whole individual.

Because of the fact that those who develop this type of arthritis have frequently had sore throats, or acute or chronic infected tonsils, or abscessed teeth, it has been thought that the disease is often due to toxins from bacteria in another part of the body. On this theory, the disease is called chronic infectious arthritis. But bacteria are not usually found in the joints themselves, and it seems likely that the difficulty is a hypersensitivity of the joints to bacterial toxins.

For many years, it has been customary to search for a focus of infection in the arthritic and to remove or cure it. Not only obvious infections have been sought, but those quiet sorts of infection that may go on unsuspected and apparently not giving trouble in the part where they are located. A second line of attack has been the use of vaccines, to desensitize the joints to toxins from unrecognized foci of infection.

Attempts to discover a specific cause for this disease, possibly a virus, have not yet been successful.

In spite of the fact that the cause of the disease often cannot be found, there is much that may be done to prevent its victims from becoming severely crippled. One orthopedic surgeon states that 80% of the cases may be greatly relieved, if bony changes in the joints have not gone too far before treatment is begun. The treatment involves the improvement of the general health in every possible way, and the care of the involved joints so as to protect them from further damage and to improve the use of them.

It seems probable that there may be an hereditary disposition to arthritis, since those who have it often come from families in which it is prevalent. For this reason, those who have arthritis in the family should give special heed to protecting the general health, and to protecting the joints from possibly precipitating factors such as exposure to cold, strain, or injury.

Osteoarthritis.

The second common type of chronic arthritis differs from the first in that it more often comes on after 40 than before; it is more common in those who are obese rather than undernourished; it probably is not caused by bacteria; and it does not cause so severe crippling.

In a given case, it can frequently be shown that there has been injury to the joints in which arthritis settles. Sometimes the joints appear to have been injured through ordinary although excessive use, as for example, arthritis in the hands of those who have done hard manual labor. Sometimes the injury results from the use of joints at a mechanical disadvantage, as, for example, in the case of the spine in those who do not carry themselves well, or in the feet or the knees in those who do not use their feet well. Sometimes the injury was an accidental one, in which the joint was strained at the time and did not fully recover.

If joints are ever so little out of their proper alignment, the joint surfaces will become irritated. Little by little, beginning at middle life, the cartilages of such joints are inclined to wear away. Usually in this disease the joints do not stiffen entirely, but motion in them is less free, and they are likely to pain. In the fingers, arthritis makes hand work less dextrous. In the knees, it makes the gait awkward, and predisposes to falls and accidents.

Whatever other causes may perhaps be responsible for a tendency to this type of arthritis, it is certain that in many cases trauma is often an important factor. With this fact in mind, an important element in preventing this disease will be the protection of the joints from any sort of injury.

Beginning in early life, it is necessary to make sure that all the joints are lined up properly for any motions that are to be made, so that they shall not be twisted or distorted. Whatever the motion to be made, it should be made in the way that is mechanically easiest for the joints. This is true even of such small motions as typing; the fingers should hit the keys straight, not at an angle. When it is a question of the larger joints, the mechanics of the body as a whole must be considered. This subject is discussed in the chapter on posture.

As for accidental injury of joints, they may continue to cause trouble if they are not properly treated at the time they occur. If neglected, a sprained joint may become the site of arthritis that gives trouble through life.

It has been noted that this type of arthritis more often occurs in the obese. Extra weight in itself places an extra burden on joints. If, in addition, the joints

are distorted by faulty body mechanics, they are still more likely to be harmed. Underlying faulty mechanical use of the body, there may be weakness of the musculature, which prevents the muscles from holding the body in its normal position. This may be the main difficulty in the obese, with fat, flabby muscles, or in any person whose muscles are not properly nourished and exercised.

To prevent undue wear and tear on joints should not be difficult in youth, but to cure the effects of it after the joints have begun to degenerate is not so easy. Nevertheless, much can often be done. Posture training after youth is not particularly successful, but sometimes by the use of apparatus (e.g. plates in shoes) or by various operations, a joint may again be restored to usefulness. In addition, there are numerous forms of physical therapy that may be used to relieve pain and to make stiffened joints more limber.

Gout.

A third type of arthritis, which may be either acute or chronic in gout. This is associated with chemical disturbance in the body (uric acid metabolism). Chalky deposits of sodium urate are formed in the joints and also in the cartilages of the ears. The disease is probably hereditary. It accounts for about 5% of arthritis. The pain in gout is very severe, but, fortunately, by dietary and medical means, it can usually be improved, if not cured.

Specific Arthritis.

In some cases of arthritis the cause is definitely known to be specific bacteria. The organisms of gonorrhea and syphilis are particularly likely to infect joints, although others may do so. Often such infections destroy joint tissues and cause crippling.

Other Conditions Affecting Joints.

When a joint gives pain or becomes stiff, the difficulty may not be in the joint itself, but in structures near it. Among these may be mentioned bursitis, tenosynovitis and fibrositis.

Bursitis is an inflammation of a small sac called a bursa ("purse") which lies between parts that move upon one another. A bursa normally is lined with a moist membrane, and serves to protect a joint and make motion at a joint easier. This is the case, for example, with the bursa on the point of the shoulder, between the shoulder joint and the large muscle (deltoid) that lies over it. Subdeltoid bursitis is a common complaint. When a bursa is inflamed, the surfaces lining it may adhere to each other and hamper motion, and cause severe pain in the joint. Often bursitis follows strain or injury of a part. The injury may be a sudden one, or a prolonged slight one. The latter is exemplified in inflammation of the bursa over the patella (knee cap) in those who have to kneel while working. This is popularly known as "house maid's knee."

If attended to as soon as symptoms appear, a bursitis usually is completely curable. If treatment is delayed, a cure may be impossible, and the joint may be partly or completely crippled.

Tenosynovitis is inflammation of the lining of a muscle tendon sheath. Ordinarily, tendons slip smoothly through their sheaths. When inflamed, the sheath may adhere to the tendon, so that no motion is possible, and the joint over which the tendon passes is immovable. Frequently inflammation of tendons of the wrists and hands arises from minor skin infections that are neglected until they spread to nearby structures. Lasting damage may arise in a few hours. Even the smallest

break in the skin should be attended to promptly if such occasional bad results are to be prevented.

Tendons also become inflamed as a result of poor mechanical use, or from accidental strain. Since most tendons pass over joints, any tendon injury may have a crippling effect upon joint motion.

Fibrositis is inflammation of fibrous tissue around a muscle. Muscle tissue itself is comparatively more resistant to injury than some of the tissues with poorer blood supply, and when a muscle gives trouble, the difficulty is often an inflammation of its fibrous sheath. The "stiff neck" which most people have occasionally experienced upon awaking in the morning is usually of this nature. So also are some cases of lumbago (fibrositis of lumbar muscles).

Fibrositis may be due to strain or cramping of muscles, exposure to cold, and various other causes. It is very much less likely to become chronic than is inflammation of joints, bursae or tendons.

Rheumatic Fever.

In rheumatic fever the joints are affected temporarily, but they recover. The danger of rheumatic fever is not crippling of the joints but of the heart. (See Chapter 25.)

GASTRIC AND DUODENAL ULCERS

The largest number of complaints in many a clinic is of "stomach trouble," and the greatest fear in many a patient is that he has an ulcer. To be sure, ulcers are common, but not all pains in the stomach are ulcers, nor yet is all indigestion with nausea, vomiting, and "heart burn." Often the difficulty is simple indigestion, or at most a mild inflammation of the stomach.

As for ulcers, their common location is near the pylorus (opening into the duodenum, or first portion of the small intestine). Those in the stomach are called gastric and those in the duodenum, duodenal. Both are also called peptic ulcers, because the immediate cause of them is erosion of the mucous membrane by the digestive enzyme, pepsin, and the hydrochloric acid of the gastric juice.

Normally the gastric juice does not have a harmful effect upon the lining of the stomach or the duodenum, for these tissues are living cells, with a free blood supply, and also are covered with the mucus they secrete. Moreover, the digestive juices usually are poured out most abundantly at times when food is in the stomach, to receive the brunt of their action. Finally, the hydrochloric acid of the stomach combining with the bicarbonate (alkali) in the pancreatic juice, and the alkaline bile, exerts some protective action upon the duodenum.

The question naturally arises, why should the gastric juice sometimes cause erosion and ulcer, and at other times not. The conclusion is that it is not so much a difference in the gastric juice as in the susceptibility of the mucous membranes of stomach and duodenum to injury. It is thought that the membranes must be either lacking in resistance, either naturally so, or because they have been made so by some irritant, mechanical or chemical.

Man is the only creature regularly subject to gastric ulcer. Also man is the only creature regularly subject to chronic worry. One investigator said that he could not continue his experimental work with peptic ulcer until he found some way to make laboratory animals worry about the stock market. This jest does express the serious opinion of many authorities—that peptic ulcer arises as a result of altered nerve control over the functions of gastric secretion and motility, whereby the tissues are affected so as to become less resistant to gastric juice.

Certainly it appears to be true that peptic ulcer arises most often in those of high strung, intense nature. Often such people are hard workers, who "drive themselves and drive others" to the last ounce of energy, sleep too little, and are chronically overwrought in mind and body. It is on such soil that gastric ulcer seems most often to arise.

It has been noted, too, that faulty eating habits are also usually present in those who develop ulcer. Often they eat hastily, in a commotion, swallow half-chewed food, and too hot food or beverages. They may have meals at irregular hours. If they have a poor appetite, they may require that food be highly seasoned. Often they smoke a great deal, and perhaps take alcoholic beverages before meals, or as a substitute for meals. All these factors might well account for a disturbance of gastric digestion, and it seems probable that they also account, in many cases, for peptic ulcer, especially in those of a "nervous" disposition. The difficulty in such cases is that the lining of the stomach and the duodenum becomes irritated and consequently non-resistant.

To add to the irritation, a "nervous" person who does not sleep well and is uncomfortable in his digestive tract may have the habit of taking self-prescribed medicines that are unsuitable for him. Many medicines are irritating to the digestive tract. At least one drug, contained in several patent medicines, has been shown experimentally to be capable of causing ulcer in dogs.

A person who does not eat well is likely to become undernourished, and this adds to the tendency to ulcer. Even animals not susceptible to ulcer may develop it if undernourished. Experimentally, a deficiency of protein may cause ulcer.

A final factor is that of infection. It appears that infection in the lower digestive tract (e.g. appendicitis) or elsewhere may make the stomach less resistant or actually cause small abscesses that pave the way for ulcer. Frequently, an infection of the upper respiratory tract has preceded the onset of ulcer, or its recurrence.

In general it is true that ulcer does not come on suddenly, but develops through stages of so-called "indigestion." Any person who has pain or discomfort in the region of the stomach after eating, either immediately or when it is almost time for another meal (so-called hunger pain) should consult a doctor. No ulcer may be present, yet there may be irritation which if not treated will lead to ulcer. As a matter of fact, many cases of indigestion are actually due to small ulcers, as has been shown by the use of the gastroscope, an instrument to show the interior of the stomach. It is thought that about 10% of persons in this country have peptic ulcers at some time in their lives.

Ulcers may heal of their own accord, and no doubt often do, but it is not safe to count upon that. More often, if not treated promptly they become chronic, and continue to cause stomach trouble, regularly or intermittently; and they may ultimately cause serious trouble. The danger is that an ulcer will grow deeper until it perforates through the stomach wall, or causes hemorrhage, or that it will obstruct the pylorus or the intestine. If not cared for, there is also some possibility that it will become cancerous.

If an ulcer has been diagnosed, by X-ray and other tests, the treatment is usually medical. In one large clinic, nine-tenths of peptic ulcers are treated medically and only one-tenth require surgery. The medical treatment includes the use of a bland non-irritating diet, usually the omission of alcohol and tobacco, the establishment of regular habits of living, and, if possible, a better state of mind. Medicines are also used. There is not much danger to life in a properly treated ulcer, but treatment must be continued over a long period, as a rule.

Often a person who actually has an ulcer considers it simple indigestion and does not see a physician until it is too late to avoid an operation. This is the case especially with those who discover that alkali relieves their symptoms. It does so, for the time being, because it neutralizes the acidity of the gastric juice. In the old days, those suffering from stomach trouble used to carry with them a lump of common tailor's chalk, from which they would take a nibble at need. Now they carry "soda bicarb" tablets, or patent medicine containing it or some other alkali. However, an increased amount of acid soon forms after taking alkali, and the symptoms are worse than before, and more medicine is required. In time, the system may be greatly damaged by the excess of alkali absorbed. It is entirely unsafe to be one's own doctor in case of continued "indigestion." To hide the symptoms is not to cure the disease.

To prevent gastric ulcer involves the avoidance of the causes that have already been mentioned. The high strung person must find some satisfactorily calm way of living, avoiding too much fatigue and emotion. He like all others must eat sensibly, care for infections promptly, and have medical treatment rather than self-treatment for "stomach trouble."

GALL BLADDER DISEASE

Next to the vermiform appendix, the gall bladder causes more trouble than any other organ in the abdomen. Probably more than half of the women over forty have trouble with the gall bladder. The saying among physicians is that one should suspect the gall bladder in cases of indigestion in women who are "fair, fat, and forty." But it is almost as common among men. Most cases occur between 30 and 50, but not even children are exempt.

The gall bladder is an important organ, and should be saved to health. And it could be, in most cases, with due precautions and proper care.

The gall bladder is a small sac lying underneath the liver (see Fig. 70). It is the storage place for bile formed in the liver. The liver produces bile constantly, up to 1,000 c.c. a day. During digestion, bile pours into the duodenum and takes part in the digestive process. It has the effect of starting the action of one of the secretions of the pancreas (lipase) which is chiefly responsible for digesting fat. In many cases of gall bladder disease, this "ignition" action of the bile is not performed, and fats are not properly digested.

When the gall bladder is out of order, it is commonly because it is chronically infected, or contains gall stones, or both.

Infection of the gall bladder is most frequently due to colon bacilli from the intestine. When a gall bladder is removed, the appendix is often found infected, and it is thought that an infected appendix may often be the starting point of gall bladder disease, or that the same conditions may lead to both diseases. Also, it has been noted that infections of the gall bladder may begin during an acute infection of the respiratory tract, such as pneumonia or influenza. Experimentally, it has been shown that a few germs from the nose, throat, teeth, or colon, if injected from time to time over a long period will infect the gall bladder in laboratory animals. In some cases, gall bladder disease comes on after a considerable period of functional disturbance of the gall bladder, in the case of those whose dietary habits are bad.

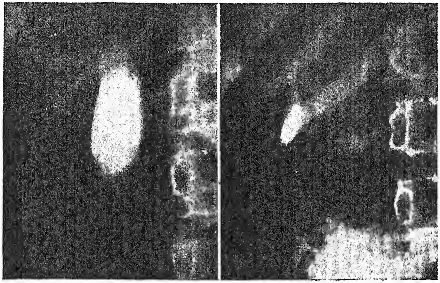
The symptoms of gall bladder inflammation in the early stages of the disease are much the same as those of indigestion from any other cause. Frequently they are described as "bilious attacks" or as dyspepsia. There is usually a sense of fullness in the upper abdomen after eating. Sometimes the individual notices that he has

trouble especially after eating a hearty meal containing much fat. Eventually there will be pain in the region of the gall bladder, just under the ribs on the right side.

Jaundice is not a symptom of gall bladder disease unless there is obstruction to the outflow of bile from the gall bladder. In such a case, bile enters the blood, and its yellow pigment colors the skin and the white part of the eyes. (The phenomenon is the same as in the mild acute disease, epidemic catarrhal jaundice.)

Once an infection has started in the gall bladder, it is very likely to become chronic if the individual does not obtain, and act upon, medical advice.

If a chronic gall bladder infection exists, it is still usually possible to control it by medical means, which include a diet suitable to the condition.



a b

Fig. 70.—X-ray photographs of the gall-bladder of a man before (a) and twenty minutes after (b) a meal of fat, the gall bladder has been intravenuously injected with dye (Graham-Cole test) fourteen hours before. Fat in the duodenum causes the gall bladder to empty. (Winton and Bayliss "Human Physiology.")

In some cases, however, it is best for many reasons that the gall bladder should be removed. Thereafter the bile flows continuously from the liver to the duodenum, and although digestion may not be quite normal, the diet may usually be regulated to meet the altered condition.

When the gall bladder is removed it is either because medical treatment does not give satisfactory results, or because gall stones have formed in it.

Gall stones are very likely to occur from the same causes as gall bladder infection, and at the same time. Because the bile is altered in its composition or does not flow as freely as usual, its salts may pass out of solution and collect in small particles. The stones may remain small, or they may gradually grow larger, in snow ball fashion.

At times, gall stones may pass through the bile duct into the duodenum, thence out of the body. Severe pain, called gallstone colic, often occurs as the stones, often with rough edges, pass through the narrow bile duct. In some cases, the stone slips back into the gall bladder, and in other cases it may remain wedged in the duct, causing obstruction and jaundice.

There is no known way of dissolving gall stones. When a surgeon finds gall stones present, he is likely to advise an operation, lest they cause continued trouble, and possibly complications.

To prevent gall bladder disease is to some extent a matter of regulating the diet. Continued abuse of the digestive tract may be an important predisposing factor. For the normal person, it is not necessary nor desirable to omit fats from the diet, but to omit merely the rich concoctions that tax digestion, and not to eat too much food at any one meal. Frequently before disease of the gall bladder appears, there have been times when its function was disturbed by indiscretion in diet. This is especially the case in those who like to eat, but do not like to exercise. Constipation has often been present for some time in those who develop the disease, and it is thought that it may create conditions that favor infection.

It has been suggested that one reason why women have this disease more often than men is that they are more likely to wear tight clothing around the waist, which may cause congestion in the gall bladder and make it more susceptible to disease. Pregnancy may also be a factor.

As in the case of all diseases in which infection plays a part, it is, of course, important to keep as free from bacteria as possible.

ASTHMA AND OTHER ALLERGIC DISEASES

Recently the term allergy has become a familiar one to the layman, who finds it useful to describe any sort of unfavorable reaction to this or that. The small boy may even use the term to tell how he reacts to school. Behind this popularity of the term lies an increasing interest in the subject on the part of medical science in the twenty-five years since allergy was first well understood.

It is reported that in the year 1939 there were 1500 physicians specializing in allergic diseases. They estimate that perhaps one tenth of the population is in some respect allergic, and that many of them can be either cured or greatly relieved.

It was long ago recognized that some people were specially sensitive to some things that did not disturb others, and that they developed such symptoms as running nose, or wheezing, or skin irritations when they smelled or ate or touched the things to which they were sensitive. As far back as 1575, a physician in Padua is reported to have cured an archbishop of asthma by having him give up his feather bed and omit certain articles of food.

The term allergy (which means altered energy, or altered reaction) was first used in this century to describe an increased state of susceptibility to various foreign substances that are harmless to the great majority of individuals. Other terms meaning much the same thing are hypersensitivity, protein sensitization, and anaphylaxis.

In the allergic person, the difficulty is that their body cells, or some of them, do not behave as normal cells do. For them, some given substance is an allergen—that is, it excites allergy.

It is the first exposure to a substance that is responsible for sensitizing a person to that substance. The first time that a person is exposed to it, it excites the formation of antibodies, called allergins or reagins. These are in theory somewhat similar to the antibodies that arise in response to bacterial invasion, and that may bring immunity against those bacteria. But in cases of allergy, the antibodies bring the opposite of immunity—that is, susceptibility. Thus, on the next occasion of contact with the same substance, a violent reaction to it occurs.

When children are born with allergy, and are made ill by their very first contact with a substance after birth, it is thought that their first exposure to it came through the mother's blood before birth. Not infrequently it happens that an infant is allergic to cow's milk the first time he takes it. Similarly, some are from the start allergic to eggs.

There is the possibility that people may inherit tissues that are prone to allergic reactions. Some authorities believe that an allergic predisposition is hereditary as a Mendelian dominant trait. Others believe that all cases are acquired, either before birth or after. Practically, it makes little difference, since the prevention and treatment of allergy is the same in either case.

A recent physiological explanation of allergy is that when antigen and antigin unite, a chemical called histamine, normally produced in many tissues, is released in amounts too great to be neutralized by its normal physiological antagonists.

The "shock tissues"—that is, those in which manifestations of allergy occur—are most commonly the respiratory tract, the skin, and the tissues of the digestive tract. The commonest allergic symptoms are asthma, hay fever, urticaria (commonly known as hives), and eczema. Various other tissues may also become sensitized, giving such allergic symptoms as swelling of the face and throat (angioneurotic edema), or headache, etc. In a given case, it is usually only one set of tissues that is sensitive, although exceptions occur, in which a person has a number of different allergic symptoms.

As for the substances that may produce sensitization, the list is very large. It includes pollens, plants, foods, drugs, chemicals, animal fur and emanations from animals, insect bites and stings, moulds and fungi, and dusts. Even physical agents, such as heat, cold, and light, may excite allergic reactions.

After sensitization has been established, various non-allergenic causes may precipitate allergic reactions. An allergic person may have an attack if he becomes nervously upset, or fatigued, or if his digestion is out of order.

To determine whether a condition is due to allergy, a physician rules out all other possible causes of the symptoms, and in addition takes a complete history of the appearance of the symptoms with reference to contacts with suspected allergens, and makes various tests for specific sensitivity. Among the latter are skin tests, which may or may not determine the diagnosis; the skin may react to many substances, and yet the symptoms be due to none of them; or vice versa. In many cases, however, skin tests and symptoms are correlated.

The treatment of allergy may consist of keeping the individual from contact with the substance to which he is sensitive; or of desensitizing him to that substance so that he may safely come into contact with it; or of relieving the symptoms so that he is comfortable and can do his work.

Dust Allergy.

Specific sensitiveness to dust often is present in those who are allergic. Experimentally, animals may be given asthma by exposure to ordinary house dust; no symptoms appear the first time they are exposed to it, but on the second exposure, several weeks later, they have typical asthmatic attacks. Air-conditioning of buildings, and a dust-free environment, offers much in the way of prevention.

Pollen Allergy.

Pollen is one of the causes of asthma, and the chief cause of hay fever. It was first described in Italy in 1565, in the case of a woman whose headache, itching

and running nose, and sneezing were traced by her physician to roses. At that time it was called "rose cold." Later it was called "summer catarrh," because it was noted that other things than roses caused it. In 1819, a physician thought he traced it to hay, in his own case. A little later it was correctly attributed to pollen, also by a physician himself afflicted.

Formerly the only thing a sufferer from hay fever could do was to try to find a region free from the pollen to which he was sensitive. Now he can often be desensitized. Such measures are successful in perhaps eighty per cent of cases. Local treatment of the nose may also be needed. Community efforts to banish weeds are not often successful since it takes only the most minute amount of pollen to excite hay fever and the pollen may travel a long way.

Contact Dermatitis.

Plants and chemicals are often causes of allergic skin eruptions. The most frequent offender among the plants is poison ivy although over 100 plants have been described as exciting allergic reactions. After contact, the symptoms of itching redness and soreness of the skin may not begin for several days. Susceptibility to the same plant or plants remains through life, unless it can be overcome by desensitization. First aid after exposure to a plant allergen consists of first washing thoroughly with strong soap and water, without scrubbing, and then with gasoline or ether. After an attack of ivy poisoning, the skin soon returns to normal unless it has been scratched and infected.

Many cases of *eczema* are due to allergy. In some cases the cause is substances taken into the mouth (as in the case of infants who develope eczema from foods), but often eczema results from contact. This occurs not infrequently from exposure to chemicals used in industry, or even in the home.

Food Allergy.

A common symptom of food allergy is urticaria or hives. Shortly after eating the offending food, red and itching areas (wheals) appear on the skin. If no more of the food is taken, the symptoms quickly disappear, but reappear when the same food is eaten again.

A rather dramatic and often serious allergic symptom is swelling of the tissues in the throat. With it, the skin of the face is also swollen. If not relieved, suffocation might take place, but fortunately it can be completely relieved in a few moments if medical aid is at hand. Those who are subject to this type of allergy usually know of it from occasional experiences since childhood, and also know which substances excite it and can avoid them.

The symptoms of food allergy may be in the digestive tract itself, or elsewhere. Occasionally hay fever or asthma is due to a food. So also may be migraine headaches.

It is thought that sensitization often occurs by taking too much of a food the first time it is taken, and then of allowing too long an interval (more than two weeks) to elapse before it is taken again. Also, it is thought that sensitization may arise as a result of taking a given food at a time when the digestive tract is out of order, allowing undigested proteins to pass into the circulation.

To discover which food causes allergy, skin tests are sometimes helpful, but in other cases scientific methods of experimenting with the diet are more useful. The physician first orders a diet containing only foods to which few people are sensitive, and then one by one adds other foods. This scientific method of exclusion and addi-

tion is preferable to the hit-and-miss methods of the layman in attempting to find out the cause of his allergy.

Having discovered the cause of a food allergy, recovery from it depends either upon avoiding that food or being desensitized to it. The latter method may involve a gradual re-education of the individual's body cells, by giving first the most infinitesimal amounts of the allergen, and gradually increasing the amount until it is tolerated. This method is useful in the case of foods which it is particularly difficult entirely to avoid.

Drug Allergy.

A large number of drugs and cosmetics have been observed to cause trouble in the allergic. Aspirin is one of the most common drugs to which individuals may be sensitive. The allergic are cautioned against using it, or any other medicine except that prescribed by a physician who knows of their peculiarity.

ENDOCRINE GLAND DISORDERS

At least fifteen endocrine hormones are well known, and there are many others about which some information has been obtained. It has been shown, in Chapter 3, how the harmonious interaction of these hormones regulates the life of the body. However, if any one of them is present in too small or too large an amount, some degree of departure from normal may result in respect to bodily stature, facial form, sex functions, general or special metabolism, or even mentality.

Stockard has stated, "Very gradual shifts in influence (among the hormones) are responsible for the constitutional and personality changes during the different periods of our lives; and more pronounced disagreements and violent disruptions among the members of the glandular oligarchy produce serious and weird diseases of growth, metabolism, and nervous and mental functions."

For each hormone there are three possibilities regarding the amount that may be secreted—a normal amount, a larger amount, or a smaller amount. Since the glands are all inter-related, if any two are considered in relation to each other, there are not six but nine variations that may be produced according to the amount of each hormone. Considering the three hormones, there are 27 possible variations; and so on. Considering the fifteen major hormones, the possibilities of variation would be three to the fifteenth power, which gives the astounding figure of 14,348,-907. If the various degrees of over-secretion and under-secretion were to be considered, and if changes of quality of the hormones as well as changes of amount, the number would be unthinkable.

Not all of these combinations represent disease. Some of them merely influence size and appearance, or qualities of mind and personality. It is thought that differences in the inborn tendencies toward predominance of one endocrine or another are responsible for racial characteristics. For example, a slight excess of one of the pituitary hormones may account for the greater average height of the European as contrasted with the African and the Asiatic. The thyroid may account for longer legs. Similarly, the pituitary and the thyroid may influence the characteristics of the hair and the skin and the conformation of the face which differentiate these races. Also, the lighter color of the European may be due to a relatively greater activity of the adrenal glands in them. Possibly also a relative predominance of the thyroid gland may account for the Caucasian's normally energetic temperament. All these endocrine factors, it is supposed, are secondary to certain fundamental inherited factors.

It is encouraging to realize that with all the possibilities of departure from normal in the balance of the hormones, no endocrine disease is an important cause of death except diabetes, which has been separately discussed on page 209. Nor is any single endocrine disease a statistically important cause of illness. But with increasing knowledge of the means of helping the endocrine system in its coordinating function, it is now possible to prevent or to remedy many departures from normal in physique and in health.

Treatment of Endocrine Gland Disorders.

For *under-secretion* of an endocrine gland, treatment often consists of administering a hormone from an outside source to substitute for one that is deficient.

The ancient Chinese and Egyptians treated certain disorders that we now recognize as gland deficiencies by feeding animal glands. As recently as 1885, thyroid sandwiches were given for under secretion of that gland. But at about that time it was discovered that animal glands could be dried and dessicated, and administered more agreeably in extract form. Also, attempts were made toward gland grafting, or transplanting living glands into the tissues of those having deficiencies. The expectation was that they would continue to live and secrete in their new location. It is only recently however, that such expectations are beginning to be realized.

During this century, the active principle (the chemical which exerts the important effect) of many of the glands has been isolated, and ways have been found to prepare them in chemically pure crystalline form, and to standardize some of them by tests on living animals. They may thus be administered with great accuracy of dosage to correct a given condition. One of the advantages of synthetic products is that they may be much less expensive than those made from animal glands, of which tons may be required to make only a few crystals of the pure hormone.

For *over-secretion* of an endocrine gland, or for disease of the gland, removal of the whole or a part of the gland is usually the treatment. If a shortage of its hormone is thereby created, the lack may often be met by the measures just indicated.

Prevention.

The prevention of endocrine gland disorders may well be founded upon the protection of the health in all possible ways. To meet all the body's requirements (for nutrition, rest, freedom from infection, etc.) is the fundamental step in protecting the endocrines. A second important method is that of medical supervision regularly from infancy onward, so that any slight departure from normal may be noted and corrected if possible. Often a slight imbalance among the endocrines lends itself to treatment by a change in hygiene or other medical treatment.

The Thyroid Gland

Goiter.

Any enlargement of the thyroid gland is called goiter. The term merely implies swelling. The secretion of the enlarged gland may be normal, or increased or decreased. A person who has a goiter should find out whether it is doing him harm and needs treatment. It may do harm if it is secreting abnormally (too much or too little), or if it is located so as to exert pressure on nearby structures. A goiter may be removed for the latter reason, or because it is secreting too much, or because its tissues have become abnormal.

Simple Goiter.

In some parts of the world simple goiter is endemic—that is, prevails quite widely among the population. The cause is that the water and food does not supply enough iodine. In these goiter regions, as many as 30% of males and 60% of females may have swellings of the thyroid gland. Even the animals and fresh-water fish may have it. The enlargement is compensatory, to supply the body with enough thyroid hormone.

In some cases, compensation is not quite satisfactory, and some individuals may suffer from under-secretion.

One of the triumphs of modern times in this country has been reducing the amount of simple goiter, by the method of supplying individuals in goiter belts

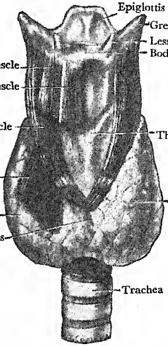


FIG. 71.—The thyroid gland.

with iodized salt. It was formerly very prevalent in some of our inland regions, and would still be so except for this preventive measure. In Michigan, in particular in the past fourteen years goiter has been reduced practically to nil, whereas formerly one in three or four had the disease. If enough iodine is supplied to children, such goiters do not occur, or may disappear even after they have occurred. In adults, the swelling usually remains. In either case, the systemic lack of iodine is corrected.

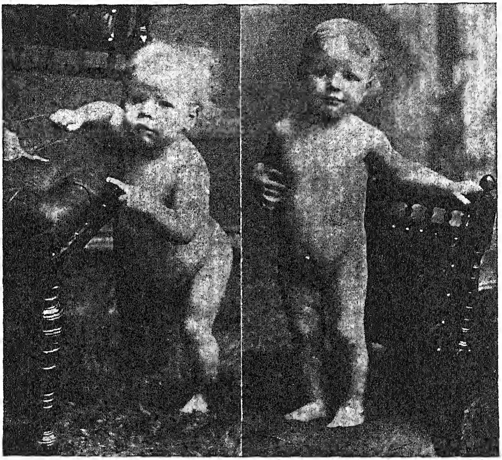
Not all goiters, even in goiter regions, are simple swellings, and iodized salt, in the case of an adult especially, should not be used except upon the advice of a physician, lest it supply a dangerously large amount of iodine.

Under-secretion.

A deficiency of the thyroid hormone may be present from birth, in which case it gives the disease known as *cretinism*. (See Fig. 72.) Normally, only about 12 milligrams of thyroid secretion are present in the body at a time, yet lacking that small amount, imbecility is the result. The body also is stunted in growth.

When the lack of thyroid hormone comes on later in life, *myxedema* is the result. This, too, seriously impairs the health of body and mind.

Minor degrees of under-secretion of the thyroid gland (*hypo-thyroidism*) often occur. Since the thyroid gland is concerned in the rate of metabolism, symptoms of hypo-thyroidism are a tendency to become overweight on a low diet, and to feel the cold. Also, because of lack of the usual degree of stimulation of the nervous system by the thyroid, there is likely to be a general sluggishness of body and mind. Other symptoms frequently are sparse, coarse hair, thinness of the outer third of the eyebrows, dryness of the skin, and a heavy facial expression.



A B

FIG. 72.—Cretin before (A) and after (B) treatment with thyroid extract. (Bachmann and Bliss.)

Under-secretion from any cause may be treated by the administration of thyroid extract—or thyroxin, its active principle—to replace that which the gland itself should provide. In many cases, the results are excellent.

Over-secretion.

An over-secretion of the thyroid especially increases the rate of metabolism and the activity of the nervous system. In mild cases of *hyperthyroidism* the individual may be thin in spite of an abundant diet, alert of mind and quick in motion, somewhat excitable or nervously irritable, may perspire freely, and have a rapid pulse and tremor of the fingers. In severe cases, these symptoms are more pronounced. In one form of the disease, exophthalmic goiter, the eyes become prominent.

A great many people without being abnormal are classifiable as either the hyperthyroid or the hypothyroid type. The hygiene of the two types is in many respects quite the opposite. The former need to check the "drive" that comes from the over-secreting gland, and the latter need more stimulation (and perhaps thyroid extract).

The treatment for definite disease of the thyroid or of conditions in which its hormone is increased in amount or changed in character, is removal of part of the gland.

A basal metabolism test is often done to determine the activity of the thyroid gland, by measuring the rate of metabolism at rest.

The Adrenal Glands

Cortex.—One of the first diseases to be related to a glandular deficiency was Addison's disease, named for the physician who first described it in 1855. In post mortem examinations of those who had died of the disease, Addison often found abnormalities, especially tuberculosis, of the adrenal glands. It was later proved to be a disease of the outer part, or cortex, of the adrenal glands, which is essential to life. Among the symptoms are pigmentation of the skin and progressive weakness. The active principle of the cortex (cortin) has now been isolated, and cortin has become of life-saving value in Addison's disease.

The so-called "hormone agriculture" has been used for this disease with success. It consists of planting seeds of the hormone under the skin. The seeds are crystals weighing only 4–7 milligrams, of pure chemical substance from adrenal glands. From the implant, the hormone is gradually given off to the body, over a long period.

Also, transplantation of a bit of living adrenal cortex into the tissues of a person with this disease has been successful in a few cases.

In the cortex of the adrenal, tumors may develop which exert extraordinary effects upon sex characteristics. The female takes on male appearance and voice. The male may become more masculine, or become feminine. The treatment of these tumors is surgical removal, which restores the individual to the previous condition.

Medulla.—The central part of the adrenal gland, the medulla, is not essential to life, but it exerts very powerful effects upon the body. Its hormone is called adrenin or epinephrin. It has normal functions that are being continuously performed, but it has, in particular, an emergency function.

Conditions that produce anger and the need for fighting, or fear and the need for flight, are met by an increase of epinephrin. This secretion helps the nervous system quickly to mobilize the body forces to these ends. When such conditions arise as need an immediate and vigorous response, the following important changes take place in the body for the purpose of making energy quickly available.

The blood-pressure increases; the rate of the pulse and the respiration increases; the blood vessels of the lungs and of the heart walls dilate; the bronchioles in the lungs dilate. These changes are all for the purpose of activating the circulation, so that supplies of glycogen and oxygen may be carried rapidly to the muscles. Simultaneously the blood vessels in the muscles themselves dilate so that they can receive more blood, and the blood vessels in the alimentary tract contract so that they will

not retain the blood that the muscles need. At the same time a large supply of glycogen is given off from the liver storehouse into the circulation as glucose, for the muscles to use in their contraction. To complete the preparations for a fray, the clotting power of the blood is increased, in order to minimise the harm from possible bloodshed.

Although the changes just mentioned occur primarily in connection with the violent emotions that excite physical response, many of them take place in connection with strong emotion even though no violence is contemplated. It should be noted that the emotions themselves are a part of the preparation for adaptation to external circumstances. A person fights better if he is "fighting mad," provided he "keeps his head." The only one of all these changes that is clearly evident subjectively may, in fact, be the emotion that accompanies the activation of the machinery of response.

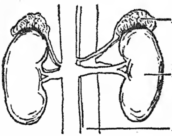


FIG. 73.—The adrenal glands, above the kidneys.

Any necessity for increased energy-production brings out similar responses. They occur, for example, in those about to take part in competition, either physical or mental. A basketball game or a spell of "cramming" is made possible by the increased energy made available through an increased secretion of the adrenal medulla. The fact that such increased energy does come when needed is not recognized by those who are never challenged to make a supreme effort.

It is worth while realizing how the adrenal glands will help out in emergencies, but there is some danger in allowing one's self to be perpetually challenged and stimulated thus; for the reaction that is normal in emergencies is excessive for everyday living. The viscera, for example, cannot be too frequently deprived of their usual blood supply without interfering with digestion and nutrition, and the one who is constantly "strung up" is likely to have indigestion and associated difficulties. Similarly, it is not desirable to cause the blood pressure to rise too frequently because of repetition of violent emotional responses. A cultivated person does not as a rule undergo so frequent or so violent emergency adaptations as does a person who cannot reason about things that frighten or anger or excite him. In a well-ordered life, the adrenal medulla tends to fill its role without being unnecessarily stimulated.

It is not certain whether disorder of the adrenal medulla, with over or under secretion, ever constitutes disease, although it is thought that some types of chronic high blood pressure may be produced through the overaction of this gland.

The extract of the adrenal medulla is used in the treatment of many conditions requiring an increase of blood pressure (e.g. in some types of shock), or constriction of blood vessels (e.g. in allergy), and in many other conditions. It is one of the indispensable drugs.

The Pancreas

(See Diabetes, page 209.)

The Pituitary Gland

The importance of this small gland, located within the skull at the base of the brain, is indicated by the names that have been given to it. It has been called

"the leader of the endocrine orchestra," "the general headquarters of the endocrine system," and the "master mind" of the endocrine company. The functions of growth, nutrition, and reproduction—the three major functions of life—are controlled by the pituitary.

Lack or excess of pituitary secretion often gives spectacular results. Too little of some of its hormones in early youth causes dwarfing, with obesity and failure of sexual development. On the other hand, too much of its hormone during the growth period may lead to giantism. It is thought that the process of growth is normally checked during adolescence by the development of the gonads, which exert a restraining action on the growth hormone of the pituitary. In later life an over-secretion of the pituitary (usually due to a tumor) may re-activate growth, giving a condition known as acromegaly. The long bones and the bones of hands and feet increase in length and width, and the bones of the face grow larger, giving a lionine appearance.

Lack of pituitary hormones may be an important factor in overweight, not only in respect to the amount of fat but in its distribution on the body. Also, it may be important in determining the amount of fluid that is retained in the tissues.

As for the use of the various pituitary hormones to make up for deficiencies, not much can be said at this time. The more that is learned about this gland, the more intricate the situation becomes. There are indications that the various hormones of the pituitary will shortly be of great value in correcting some of the defects produced by deficiency. For example, an extract of the anterior lobe has been successful in increasing growth of experimental animals (e.g. salamanders and rats), and in some cases in humans. Also, another pituitary hormone has been used experimentally for weight reduction, especially in cases in which fat is deposited irregularly (e.g. in the lower half of the body). Such use of hormones is, however, in the experimental stage.

An extract of the posterior lobe of the pituitary (pituitrin) has long been used as a medicine. It has the effect of increasing the contraction of smooth muscle, especially of the uterus, and is sometimes used as an aid to childbirth.

For over-secretion of the pituitary, usually due to a tumor, removal of the tumor often gives brilliant results.

The Gonads

The gonads are the reproductive glands (ovaries in the female, and testes in the male). Besides producing the sex cells for reproduction, these glands also produce internal secretions that affect the development of the sex organs and the sex impulse, and many functions of the reproductive system.

Several hormones are produced in each sex, and each is related to hormones of the pituitary and the adrenal. The situation is extremely complicated, and is just beginning to be understood.

It has long been known that removal of the gonads (castration) before sex maturity has been reached prevents the development of sex organs and characteristics and the sex impulse. In some cases, characteristics of the opposite sex appear. For example, the castrated young stag does not develop antlers, whereas the spayed (castrated) young deer develops horns. A castrated male human is called a eunuch.

In humans, castration of the young male delays ossification of bones, so that they grow long, giving an increase in height; fat is deposited in feminine fashion; the voice remains high pitched; and body hair does not appear. Also, the sex

organs remain immature in form and function, and sex feeling is deficient. In the female, the appearance does not become typically feminine, indeed may be somewhat masculine, and menstruation does not appear. If castration is done after full development, less pronounced changes in appearance and in sexuality occur.

Hyposecretion of the gonads may be present at any time in life. If extreme, it gives the same effects as castration according to the period of life at which it occurs. Minor degrees of lack of one or another of the sex hormones in varying degree disturb sex functions. When the gonads do not secrete enough of their hormones, it maybe because of disease in them, or because their secretions are not properly stimulated by other glands.

At middle life, in both sexes, the gonads begin to be less active. This results in the female in the cessation of menstruation. In both sexes, a shift in endocrine balance is necessary at middle life, to compensate for the waning gonads, and there may be a period when various symptoms occur as manifestations of this change. In both sexes, there may be a somewhat reduced interest in sex, although the sex impulse is apparently not entirely dependent upon active gonad secretion.

Several hormones from the gonads (e.g. estrogen from the female, and androgen from the male) are being used in treatment of disorders of reproductive functions, with some success when it can be definitely determined which hormone is deficient.

The Parathyroid Glands

The parathyroid glands are small bodies located behind the thyroid gland. Their importance was discovered when they were accidentally removed while removing the thyroid gland. A disease called tetany appeared, with disturbance of muscle action. It was then discovered that these small glands are necessary to the proper use of calcium in the body. A lack of their secretion may be overcome by the administration of an extract of parathyroid glands (parathormone).

An excess of parathyroid hormone gives rise to an increased amount of calcium in the blood, at the expense of the bones, which weaken as a result.

The Thymus Gland

The thymus gland (in animals, sometimes called the sweetbreads) is located low in the neck, largely behind the sternum. It is presumed to be, although not definitely known to be, an endocrine gland. It is largest before birth and in the first few years of life, and after puberty it tends to disappear. It has been thought to aid in skeletal growth, and to inhibit sex maturity until growth is attained. Some clinical observers believe that persistance of this gland after the time when it usually atrophies leads to large stature with sexual immaturity, and that the reverse is the case if atrophy occurs too soon. One of the known functions of the gland is the production of some of the white cells of the blood.

The Pineal Gland

The pineal gland (or body as it should be called, since it is not known that it produces a secretion) is thought to be the remnant of a primitive third eye. It is located below the cerebral hemispheres. The philosopher Descartes considered it the seat of the soul.

PART 4

EFFECTIVE USE OF MEDICAL SCIENCE

Chapter 13

BEGINNINGS OF MEDICINE

At the dawn of his existence man must have been a terror-driven creature facing a hostile world. Everything must have seemed to him to be against him. He had to cope with the phenomena of nature—storm, wind, hail, snow, lightning, freezing cold and blistering heat; with creeping and crawling things and wild beasts; with vegetation that might sustain him if he could find it or grow it, but might be lacking, and if found, might poison him; and with his fellow man, not yet recognized as fellow.

But man was man even then, with a brain to think, and the impulse to do. Man has ever been active, never passive, in the face of danger. And he has always sought causes. So he evolved a theory since known as animism. All things, living or not, possessed a soul or spirit. The spirit in a thing might be favorable to man, or unfavorable. If it was favorable, he worshipped it. The sun, for example, was thought to be generally favorable, and as such was worshipped. When evil of any kind came to primitive man, the explanation of it was easy—a demon, or evil spirit, had caused it. If, for example, a rock fell on him, it was the demon in the rock that was angry with him. When a dire illness came upon him, primitive man felt that a demon had taken up its abode in him, and he was "possessed" by it.

The belief in demons is universal among primitive peoples both ancient and modern. Biblical literature and the literature of ancient Greece abound in references to them. Homer, 1000 B.C., in the Odyssey tells of a sick man pining away, "one upon whom a hateful demon had gazed." Socrates said he had within him continually a demon, but he considered his demon as a guardian spirit. Aristotle too, the son of a physician, speaks of demons as both harming and also inspiring the possessed. Empedocles, 490–430 B.C., was puzzled about the nature of demons. He thought they were "of mixed and inconstant nature" sometimes favorable, sometimes not. Although he attributed to them nearly all the harm that befell man, he thought that with proper coaxing they could be made to relent.

The effort to cause demons to relent was the first method of preventing and curing disease. Man felt that if he could only placate the demons in some way, or ingratiate himself with them, they would either leave him alone or perhaps become favorable. Naturally, the most intelligent member of the group was relied upon to furnish suggestions about how this could be accomplished. In ancient days one such person by common consent became both the priest and the "medicine man."

The methods of driving out or exorcising demons were picturesque—ceremonial dances (the origin of the dance) in special costumes and decorations (the origin of dress and make-up) with incantations (the origin of music) and all sorts of magic rites and ceremonies carried out by the medicine man and the group. In everyday life, people carried with them or wore on their persons various sorts of charms and talismans ("lucky stones"). Upon occasion they made trips to spots where the good spirits dwelt and took them offerings and sacrifices.

Much recorded history is available regarding the beginnings of medicine among the peoples whose civilization forms our own cultural background—the Indo-Europeans who settled along the Nile (Egyptians), between the Tigris and the Euphrates (Babylonians), and in Canaan (Hebrews). All these peoples left many records behind them; the Egyptians, in hieroglyphics on columns and tablets, and especially in the Ebers papyrus and the Smith papyrus; the Babylonians on 30,000 tablets of clay and stone in cuneiform writing; and the Hebrews in their Scriptures.

In all these civilizations and in the Oriental countries, in fact in all countries from which information is available, it appears that medical practice developed along the same lines, beginning as pure magic. In China, for example, the cause of malaria was held to be three demons: "one with a bucket of cold water to give the chills, another with a stove to set up the fever, and a third with a hammer with which to knock the head and produce headaches."

At the time of earliest recorded history, man had already begun to take things internally for the treatment of illness. The substances first used as medicines were from the animal world, on the theory that the virtue of the animal would be imparted to the one who partook of its flesh. For example, the lungs of a fox were used in order to increase the "wind" and to cure lung disease, and the heart of a lion to increase courage and physical strength. In other cases, the animal substance was consumed with the idea of destroying its evil spirit, and thereby banishing the disease. For example, a

popular remedy for the children's diseases was a whole skinned mouse. These have been found in the stomachs of child mummies. Since the treatment was not abandoned for centuries, some children must have survived it. Pliny in the first century of the Christian era was still recommending it for toothache.

In trying to find the animal source of the evil spirits of disease, sometimes the ancients stumbled upon a useful form of treatment—for example, fish liver oil, which has been used for rickets for 6,000 years.

Vegetable substances were also used early in history, on the same principles. If such a substance proved beneficial it was because the spirit or the virtue of the plant was imparted to the person who consumed it. The name for alcohol—"spirits"—had its origin in that theory. This, and some of the other vegetable substances then used—for example, opium—have been in use ever since. No mineral medicines were used until after the Renaissance.

Surgery was widely practiced in ancient times. Naturally enough, one of the first operations was that known as trephining of the skull. In the belief that a demon was locked within the skull causing physical or mental distress, the ancients did not hesitate to make a hole to let the demon out. From the amount of healing in the skull bones of mummies, it appears that many of the patients must have survived. The eye also was often operated upon, but apparently not always with success; in the Code of Hammurabi the punishment for failure is stated, "If a physician has removed a cataract from a patrician and has made him lose his eye, his hand shall be cut off." The penalty in the case of a slave was giving the owner another slave.

Imhotep.

In ancient Egypt, the priest Imhotep stands out as the first great physician known by name. He lived about 2700 B.C. After his death he was worshipped as the god of medicine and the patron of physicians. The inscription on a memorial to him reads "under whose protection life is dealt to all men." His temple stands at Memphis. Whether through his influence or not, medicine was the major interest of the Egyptian civilization for centuries thereafter. The Ebers papyrus dating from about his time, gives over 800 prescriptions for medicine, and the Smith papyrus is an extensive account of surgical procedures. In that time, women also practiced medicine. A tomb was uncovered in 1930 of a high priest of the Vth dynasty and buried beside him was a tablet giving his mother's

name and the title "chief Physician." Cleopatra in her time was noted as a physician as well as a ruler. She was probably the first gynecologist.

Asclepios.

Although the science of medicine was destined to take its first great forward step in Greece, conditions for a thousand years prior to that time were much the same as in other countries. The god of healing was Asclepios (Esculapius). He was born a human, so tradition says. The story is that he was the son of Apollo and Coronis. His birth is said to have been by the Cesarian method. Just before his mother died, Apollo took his son from her, through an incision in the abdomen. Asclepios became a great physician, so successful, in fact, that Pluto, ruler over the abode of dead, feared that his realm would be deserted and complained to Zeus, who slew Asclepios with a thunder bolt. There appears to be no doubt that this legendary hero really lived, and influenced medicine enormously. It seems probable that the Greek interest in the perfect body arose with him.

Throughout Greece after the death of Asclepios, scores of temples sprang up as shrines for his worship. The most famous of these was at Epidaurus, on a hill in the vicinity of a natural spring. Before this marble temple stood a statue of Asclepios and his two daughters, Hygeia, the goddess of health, and Panacea, the goddess of healing. For the first time in history the two major aspects of medicine were distinguished. Asclepios may be looked upon as the first physician of preventive medicine and hygiene.

The temples of Asclepios were really health resorts or spas. Over them presided the priests, who, through their patron saint were permitted to make cures. Among the forms of treatment, bathing, fasting, prayers and sacrifice were used, together with any medical or surgical treatment that happened to be needed. The final feature of the cure was the "temple sleep" during which the god came with his magical healing powers. To the god was given all the praise for the cure. Many marble votive tablets have been unearthed that formerly adorned the walls of these temples of Asclepios telling of the gratitude of the healed.

Hippocrates.

Hippocrates was one of the fifteen illustrious men who adorned the Age of Pericles. Born 460 B.C. the son of a temple priest, he became the Father of Medicine. He has been given that title because he was the first physician to look for the causes of disease in man

himself and his environment. Without losing his faith in his gods, he felt that man should not rely so fully upon them but should accept more of the responsibility for his own health. He believed the gods intended mortals to find out things for themselves.

This theory he put into practice in his profession. As he sat by a patient's bedside he recorded every single thing that he observed. Among his writings, afterward gathered together by Ptolemy, are

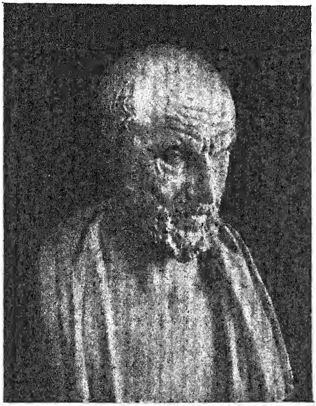


FIG. 74.—Hippocrates of Cos (460–357 B.C.).

forty-two of his clinical records, the first in history, and models even today of the most painstaking and precise observations.

Hippocrates was not only the father of medicine, but of experimental science in general. He said, "In order to cure the human body it is necessary to have a knowledge of the whole of things." Therefore he conducted planned experiments, calculated to reveal that which was hidden. For example, he performed the experiment of breaking open an egg at various stages of its development, and described what he found in a treatise on "*The Origin of the Child.*" This method of deliberate investigation was new to the world.

One statement of Hippocrates marks the break he made with the past, and the step he took into the future. "To know is one thing:

merely to believe one knows is another. To know is science to believe one knows is ignorance."

To Hippocrates science owes the following methods, which it has used ever since:

a. accurate studied observations, not merely casual observation of the obvious, but a genuine effort to observe fully, and to find things to observe;

b. complete recording of facts, that others might check them with their own observations;

c. correlation of facts, by assembling all facts bearing on the same subject and comparing them;

d. reaching conclusions based upon demonstrable facts handled in a logical manner.

Aristotle.

Although he is best known as a philosopher, Aristotle was also a great biologist. In fact he is entitled to be called the father of biology, and, as such, one of the greatest contributors to medicine. Aristotle appears to have been the first to see that all living things are related to each other as links in a chain of life, ranging from the simplest to the most complex, with man the most complex and highly developed. His aim was to classify and systematize all forms of life.

Pursuing Hippocrates' studies still further, Aristotle described the embryology of the chick in a way that even today arouses admiration. He may be called the "father of embryology."

In genetics, Aristotle showed profound interest, and raised many interesting questions. For example, he asked where blackness was hidden when it did not appear in the first generation of a mixed mating, but did appear in the second. But to these questions he had no answer. It remained for Mendel to answer them more than two thousand years later.

A great amount of excellent work was done by others at the time of Hippocrates and Aristotle. Medical science never moved at so rapid a rate again until the past hundred years. A significant thing is that the Hippocratic method has never been supplanted, but merely added to. What has happened since then has been the increase of knowledge by the use of the experimental methods first used in ancient Greece.

Shortly after Aristotle's time, the glory that was Greece waned. But Alexander the Great transplanted Greek learning to Alexandria about 330 B.C. The first medical school was established there with

Herophilus the anatomist, and Erasistratus the physiologist. The two other medical schools of that time were at Corinth and Symrna. Later, when Alexandria fell, much of the Greek learning was kept alive in Arabia, and in the Roman empire.

Celsus.

The great figure in Roman medicine was Celsus, who lived at the beginning of the Christian era. He introduced the Hippocratic method into Rome, and made studies of his own according to that method. His monumental writings *De Medicina* covered the whole

Fig. 75.—Aristotle (384–322 B.C.). (Courtesy Ciba Co.)

field of medicine, but only that dealing with surgery is preserved. Perhaps more than for anything else, medicine is indebted to Celsus for his classification of medicine into three fields: regimen and dietetics; internal treatment by drugs; and surgery. His description of the symptoms and signs of inflammation, as true now as it was then, was mentioned on page 85.

Two others of that period, both Greeks, deserve mention. Areteus, who is considered to rank next to Hippocrates as a physician, made many important observations, the most notable of which was that insanity is a disease, not possession by demons. In the second century appeared another Greek, Dioscorides, who served as physician in the Roman army. He set himself to the classi-

fication and study of the substances used as medicines, and of their precise effect upon the human body. Of the 600 plant substances he so accurately described, 90 are still in use. His work on materia medica, in five volumes, was the only work of its kind, and held its authoritative rank for sixteen centuries thereafter.

Galen.

Probably no other man in all medicine has had so much influence as Galen, the reason being that the Dark Ages set in shortly after his time and it was his 180 volumes on medicine that served as the only guide to physicians throughout that entire period.

Fig. 76.—Galen [129(?)–200(?) A.D.]. (Courtesy Ciba Co.)

Galen was a Greek from Pergamos, who began studying medicine at the age of 16 at the medical school at Alexandria. Most of his life was spent in Rome where he was the physician of the Emperor Marcus Aurelius. He was a profound student and performed many physiological experiments. For example, he learned that the blood was contained in tubular vessels and that arterial blood was different from venous. But he had a bad fault: when his studies did not supply the answer, he guessed. It is unfortunate that his fanciful theories were the ruling opinion at the time that medical study declined in Europe. During twelve centuries, physicians thought they must be wrong if they discovered something that did not correspond with what Galen had said.

Rhazes and Avicenna.

After the fall of Alexandria, Greek learning was preserved not only in Rome but also in Persia and Arabia. A medical school was established in Persia in 340 A.D. by students from Alexandria, and another later at Bagdad. Harun-al-Raschid, of Arabian nights fame, the Caliph of Bagdad, was the great patron of medical science at that time. He is said to have offered 100 tons in gold and eternal peace to Constantinople in return for the services of a certain Greek scientist as lecturer at the Bagdad medical school. At the same time, however, astrology was taught as a means of making diagnoses.

The great physician of Arabia was Rhazes. He taught in the medical school and also presided over a large hospital. Among the diseases that he accurately described were smallpox and measles. His books, over 200 in number, were the authoritative works all over Islam in the 9th and 10th centuries, and were later used in Europe.

Another physician of note at that time was Avicenna, a Persian from Bokhara, known as the "Prince of physicians." His encyclopedia of medicine, published about 1000 A.D., soon rivaled Galen's works among the medical men of Europe.

The significance of Arabian medicine is very great, for it preserved the valuable learning from the past, especially the scientific method of Hippocrates and his followers, and later made contributions of great importance to the development of medicine in Europe. Arabian medicine entered Spain with the Moorish invasion, and it entered Italy with the returning Crusaders.

Roger of Salerno.

The University of Salerno, founded in 1150, was the first in all Europe to have a medical school. It was established by the Benedictine monks. During all the time since Galen his books had been preserved and his wisdom had been applied in Europe chiefly through the monasteries. The founding of this medical school marked the beginning of a new epoch. For the first time in Europe since Galen, physicians were professionally trained. The medicine taught there was a mixture of Galen's teachings and that of the Arabians.

From Salerno came an interesting volume called the "*Regimen Sanitatis*" or rules for healthful living. It consisted of humorous rhymes for the laity. Many of these are familiar to this day—for example, "Joy, temperance and repose slam the door on the doctor's nose." This volume was composed by Roger of Salerno for Robert, Duke of Normandy, son of William the Conqueror, who was wounded in the First Crusade and stopped at Salerno for healing. Although at first it consisted of only 360 lines, 3000 more were added. The book became so popular that 240 editions of it were published and it was translated into many languages. Queen Elizabeth had it translated into English. This first book on hygiene was the forerunner of many similar volumes published during the next few centuries. Roger may be looked upon as the "father of hygiene."

Paracelsus.

Paracelsus Theophrastus Bombastus of Hohenheim, born 1493, is one of the most picturesque figures in medicine. His name itself was self-chosen, to indicate that he was the Celsus of modern times. Bombastus appears to have been added by others, to describe his most conspicuous trait. Although he died a violent death, presumably at the hands of conservatives in medicine, he had made many much needed reforms while he lived his short but vigorous life.

Paracelsus began his career auspiciously with an appointment as professor of medicine at the University of Basle, but before his class at its first meeting he made a bonfire of the books of Galen and Avicenna, and proceeded to give his lecture in German instead of the classical Latin of science. Basle kept him two years in spite of his radicalism. In the meantime, he had succeeded in breaking the link with the past, and had started the development of the science of chemistry. Up until his time chemistry had been alchemy, the center of chemical interest being the attempt to turn base metals into gold. Paracelsus told the alchemists that it was their business to make medicines, not gold. It was Paracelsus who first introduced minerals as medicines—iron, sulphur, lead, antimony, mercury, etc. Mercury soon became widely used for syphilis, and is still used for the same purpose. He thought that there ought to be a specific drug for each disease, if it could only be found.

FIG. 77.—Paracelsus (1493–1541). (Courtesy Hoffman La Roche.)

One of the great concepts of Paracelsus was that the body had self-healing power. He said "Let it be known to all men then that had not God created and placed in the bodies of men natural remedies and a natural physician, then, notwithstanding all the efforts of our physicians, not a single creature of earth would remain alive."

Paracelsus may be called the "father of biochemistry" since he was the first to hold that life processes are chemical.

Vesalius.

Vesalius (1514–1564) was the first of the great group of medical discoverers of the Renaissance. He is known as the founder of the science of anatomy. A Belgian by birth, he did much of his work as professor of anatomy at the University of Padua. Before his time,

the only knowledge of anatomy came from study of animals. In spite of the need for the greatest secrecy, Vesalius managed to carry on dissection of the human body, although he barely escaped death at the hands of the Spanish Inquisition for his impiety. His great book "*De Humani Fabrica*," a volume containing 300 beautiful illustrations, was published when he was only 28 years old.

FIG. 78.—Portrait of Andreas Vesalius (1514–1564) in a contemporary book on anatomy. (Courtesy Ciba Co.)

Harvey.

As was natural, the next discoveries were made in physiology. William Harvey is considered the "father of physiology" because he first made planned experiments designed to reveal how the body works. Also, he was the first to use mathematics to solve a problem of physiology and to measure a vital process. The process he investigated was the circulation of the blood. Up until his time the heart had been considered an organ to warm the blood, and the lungs to cool it. Harvey announced in 1628 that the heart is a pump, that the arteries contain blood, not air, and that the blood circulates. He mapped out the route of the blood throughout the body, except that he did not discover the capillaries.

Although this work at Cambridge University in England laid the foundation for physiological methods, Albrecht von Haller, a Swiss physician, 1708–1777, first made physiological investigations on a wide scale, and published the first textbook on physiology.

Malpighi.

Little had been learned about the minute structure of the body until after Galileo, born 1564, invented the compound microscope.

Malpighi (1628–1694) in Italy, was the first to use the microscope for the systematic study of the tissues of the body. The first reference to the cellular structure of the body had appeared in England in 1665 when Robert Hooke in his book "*Micrographia*" described "little boxes or cells distinct from one another." Malpighi made it his life work to study these "little boxes" making up the

human body. As would be expected, one of the things he discovered was the system of capillary blood vessels—a discovery that was needed to complete the understanding of the circulation. Malpighi is known as the father of microscopic anatomy.

Sydenham.

Thomas Sydenham (1624–1689) is known as the English Hippocrates, for he was a great clinical physician—the first to warrant that title since the time of Hippocrates. He was born into a world still given over to superstition and magic. The new discoveries

FIG. 79.—A bezoar stone, gallstone of the Persian bezoar goat, thought during medieval times to have magical healing power. Gold basin with a bezoar mounted in gold. Portugal, first half of the 16th century. From the treasury of the imperial house of Habsburg. Kunsthistorisches Museum, Vienna. (Courtesy Ciba Co.)

had hardly affected medical practice at all. Physicians were still using astrology, palmistry, amulets and charms.

It was still thought possible to cure diseases by transferring them from the sick to some object, animate or inanimate. For example, Sir Kenelm Digby suggested as a good treatment for "fever and ague" the following; "Pare the patient's nails, put the parings in a little bag, and hang the bag around the neck of a live eel, and place him in a tub of water. The eel will die and the patient will recover."

Precious stones in those days were precious not only as ornaments but also as remedies. An emerald, for example, was supposed to cure convulsions, and an agate a headache. To do the most good,

precious stones were supposed to be applied to the part of the body affected—for example, on the chest for a cough.

From the 5th century almost to modern times, monarchs took a hand—quite literally—in healing. The "King's touch" was supposed to have miraculous powers. In the Middle Ages the monarchs of the different countries specialized in their healing. The kings of Spain, for example, cured madness, and the kings of England cured a malady called King's Evil, which appears to have been any swelling of the neck. Shakespeare tells of such cures:

> "Strangely-visited people,
> All swollen and ulcerous, pitiful to the eye,
> The mere despair of surgery, he cures:
> Hanging a golden stamp about their necks."

In England, Edward the Confessor was the first to practice the art of healing. He is said to have "touched" 533 persons in one month, at a shilling a touch. Pepys reports that Charles II in the first four years of his reign used the "royal touch" on 24,000 persons, all of whom were cured.

Sydenham waged war not only against superstition but against the unscientific medical practice of the times—such, for example, as the following, which was given to Charles II when he fell ill.*

"According to the records, King Charles fell unconscious at eight o'clock in the morning, while shaving in his bedroom. His physician, on being summoned, bled the King to the extent of a pint from his right arm. Next he drew eight ounces of blood from the left shoulder, gave an emetic to make the King vomit, two physics and an enema containing antimony, rock salt, marshmallow leaves, violets, beet root, camomile flowers, fennel seed, linseed, cardamom seed, cinnamon, saffron, cochineal, and aloes. The King's head was then shaved and a blister raised on his scalp. A sneezing powder of hellebore root was given to purge his brain and a powder of cowslip to strengthen it, for it was the belief in those days that the nasal secretion came from the brain. The emetics were continued at frequent intervals and meanwhile a soothing drink given, composed of barley water, licorice, sweet almonds, light wine, oil of wormwood, anise, thistle leaves, mint, rose, and angelica. A plaster of pitch and pigeondung was put on the King's feet. Next there was more bleeding, followed by the administration of mellon seeds, manna, slippery elm, black cherry water, extract of lily of the valley,

* *Howard W. Haggard, M.D.* "*The Doctor in History*," Yale University Press.

peony, lavender, pearls dissolved in vinegar, gentian root, nutmeg and cloves. To this mixture were added forty drops of the extract of human skull. Finally in desperation bezoar stone was tried. The King died."

Thomas Sydenham is honored especially for being the first to condemn the giving of so many medicines at a time. He suggested that it would be better to give drugs singly, and to observe carefully the results each drug produced. The physicians of his time were horrified. Many of them still believed in the possibility of a *theriaca*, a combination of hundreds of drugs that would serve as a universal medicine to cure all diseases. To be sure, no one had succeeded in producing a theriaca that met expectations, but many had tried. The original idea is credited not to a physician but to a king—Mithridates the Great. Through the centuries the hope never waned that a theriaca could be found. Sir Walter Raleigh is said to have worked on this problem while imprisoned in the Tower of London.

In still other ways Sydenham aroused the suspicions of the medical men of his time. For example, he said "The health of a city profiteth more by the arrival of a good clown than of twenty asses laden with drugs." They thought that he lacked respect for drugs, but his successors in the twentieth century know that he laid the foundation for the modern use of drugs—that is, the use of drugs whose properties are understood and at times when they are needed.

Morgagni.

As a result of the work of Vesalius and Malpighi, the normal anatomy of the body had been placed on a sound foundation. However, little study had been given to abnormal anatomy. In fact, the concept had hardly arisen that disease produced changes in organs, and that these changes caused the organs to function differently and to give the symptoms of disease. Disease was still looked upon as a more or less general phenomenon, not having a particular origin in a particular organ.

Morgagni, of the University of Padua (1682–1771), was one of the first to be interested in finding out precisely what happens to the body structure during disease. Whenever he could, he obtained permission to make post mortem examinations. Then, comparing what he found after death with the story of the illness during life, he was able to state what change in an organ corresponded with a given symptom. He described the pathological processes in many diseases and showed why they gave the symptoms

they did (e.g. angina pectoris). Morgagni's work marked the beginning of the science of pathology—the science of disease processes in tissues and organs.

Virchow.

In the following century the study of pathology was carried farther by Virchow (1821–1902). He showed where the real trouble lies in disease. Morgagni had shown that it lies in diseased organs; Virchow showed that it lies in diseased cells composing those organs. Malpighi had shown that the body is composed of cells; Virchow showed the changes these cells undergo in disease. Virchow studied the cell from every point of view, and is known as the father of cellular physiology and pathology.

After Virchow's discoveries, the next question was why cells undergo the pathological changes which undermine health. One of the answers came promptly, through the work of Pasteur and Koch.

Fig. 80.—Louis Pasteur (1822–1895). (Courtesy Hoffman La-Roche.)

Pasteur and Koch.

These two men share the honor of discovering bacteria as the cause of many human diseases. Leading up to this discovery, were several previous observations of importance. First, Kircher, a Jesuit priest and physician, in 1659 had noted "small worms" in the blood of patients with plague, in milk, meat, cheese and putrefying matter. Since his microscope magnified only 32 times, these could not have been bacteria. Then Leeuwenhoek, in 1683, an Amsterdam linen merchant, whose hobby was microscopy, and who had a better microscope than Kircher's, announced that he had seen "animalcules" in human secretions and excretions. There was some speculation among physicians at the time whether these small living things had anything to do with disease. In 1761 Plenciz in Vienna announced clearly that he thought they had—in fact that they were the cause of all disease.

During the next hundred years, there was much study of microorganisms, and it was proved that they were not small animals, but plants. Several investigators suspected bacteria of being the cause of certain specific diseases. It remained, however, for Pasteur in France and Koch in Germany to link a given sort of bacteria to a

given disease, anthrax. Each made the announcement in the same year, 1876.

The science of bacteriology began with the work of these two men. With incredible patience they worked in their laboratories, bringing first one infection and then another into the light, establishing not only bacteriology but also immunology, and thereby laying the foundation for a new civilization in which man could become free from the most deadly foes of his health and happiness.

FIG. 81.—Claude Bernard (1813–1878). (Courtesy Hoffman La-Roche.)

Bernard.

One of those to whom modern science owes the most is Claude Bernard, 1813–1878. He investigated the normal working of the normal body. Not only did he himself discover important facts (e.g. that the pancreatic juice digests fats, and that sugar is formed in the liver) but he inspired many others with his enthusiasm for research in physiology, and gave them an example of painstaking technique. Many of our first departments of physiology were established by American physiologists who had been his pupils in Paris.

The Modern Period.

The men whose names have been mentioned stand out as bright lights in a dark world. In the past fifty years the whole world of medicine has become bright, with the light from a thousand laboratories. All the sciences begun in the past have been brought to a high level of development—and, still more important—they have been correlated, and the gaps between them filled in. Every bit of knowledge gained in the past and in the present fits into the whole.

Furthermore, the same thing has happened in other sciences, that had had similar scattered beginnings. They too have become unified as coherent bodies of knowledge.

Most important of all, the sciences have become Science, comprising all truth demonstrable by its methods. The facts of one science are verifiable in any other that uses the same tools and technique. And, too, the facts of one science are often usable by another science.

Medicine has taken its logical place as one of the biological sciences, in the closest family relationship with others of the same

group. But it uses all science that furthers its ends. Witness the newest great invention of physics, the atom-smashing cyclotron, already being used in the treatment of cancer. To name the heroes of modern medicine would be to name not only strictly medical heroes, but also many chemists and physicists. And to name the heroes would be an unending task, for the work of each hero today represents a vast amount of equally heroic work on the part of many a scientist who forged single links in the chain of discovery.

From its beginnings in isolated discoveries here and there, separated by years—even by centuries—medicine has come far, but it has learned how to go farther. Problems, serious ones, remain to be solved. But as the first biologist, Aristotle, said, "To know what to ask is already to know half."

Chapter 14

THE MEDICAL PROFESSION TODAY

In Spain in the 12th Century there lived a Jewish physician, Maimonides, who expressed his feeling regarding the practice of medicine in words that were unforgettable. The Oath of Maimonides has doubtless been repeated by thousands of physicians in the past eight centuries, and will be for as many centuries to come.

"*Thy Eternal Providence has appointed me to watch over the life and health of Thy creatures. May the love for my art actuate me at all times; may neither avarice nor miserliness, nor the thirst for glory, or for a great reputation engage my mind, for the enemies of Truth and Philanthropy could easily deceive me and make me forgetful of my lofty aim of doing good to Thy children.*

"*May I never see in the patient anything but a fellow creature in pain.*

"*Grant me strength, time and opportunity always to correct what I have acquired, always to extend its domain, for knowledge is immense and the spirit of man can extend infinitely to enrich itself daily with new requirements. Today he can discover his errors of yesterday and tomorrow he may obtain a new light on what he thinks himself sure of today.*

"*O God, Thou has appointed me to watch over the life and death of Thy creatures; here am I ready for my vocation.*"

The Science of Medicine.

Steadily through the ages man's knowledge of himself and other living things, and of the non-living environment, has advanced until it is justifiable to call one branch of that knowledge the science of medicine. It is the branch of science that deals with man himself in sickness and in health. With the aim of decreasing sickness and increasing health, it must sieze upon every bit of knowledge from any other science that would throw light upon any of the myriad aspects of man's life. While much of its advance has been due to study in its own special fields, so also has much come from a number of other fields. This chapter will therefore begin with a description of the sort of knowledge that is everywhere recognized today as fundamental in the *study of medicine.* Succeeding sections deal with

the two major fields of medicine; *research*, and the *practice of medicine*, with reference to special branches of practice. The purpose of this discussion is that of aiding the reader to make effective use of medical science for his own needs.

MEDICAL EDUCATION

An editorial in "*Hygeia*," August 1938, stated: "Except for a naval aviation officer the physician today is the most highly trained person in our civilization." The minimum requirements include not only a high school education, but two to four years of college

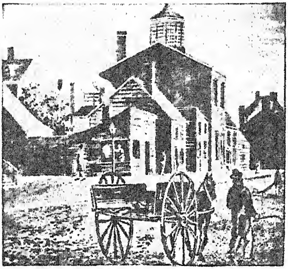


FIG. 82.—First Medical School, Philadelphia, 1765. (Menley, James Company.)

education, four years of medical education, one or two years of interneship, and usually three to five years of assistantship to another physician to prepare for work in a special field. It has been estimated that the cost of a medical education ranges from $8,000 to $12,000.

The subjects studied in college and in the first two years of medical school are the following foundation sciences:

(1) *Physics;* the science dealing with the constitution and properties of matter, especially the laws of nature in regard to forces and energy, including mechanics, heat and electricity.

(2) *Chemistry;* the science that deals with the composition of matter and of the changes it undergoes.

(3) *Zoology;* the science that treats of animals—their structure, function and development—from the lowest to the highest forms of life.

(4) *Embryology;* the development of organisms from their most rudimentary form, the single cell.

(5) *Anatomy;* the structure of the body, and

(6) *Histology;* the microscopic structure of the body.

(7) *Physiology;* the functioning of the body and its various parts.

(8) *Pathology;* the science of morbid or diseased conditions, their cause and their nature.

(9) *Bacteriology;* the branch of biology that deals with bacteria and similar microorganisms.

(10) *Pharmacology;* the properties of drugs and their action on the human body.

Throughout his medical course, the student spends much of his time in laboratories studying the subjects mentioned above, and still others. Also, he spends much time in hospital wards and clinics, studying human beings, and learning how to diagnose and treat their ailments and how to keep them well. In most medical schools he will have teaching in all the various specialties as well as in the two major clinical subjects, medicine and surgery.

There are 67 approved medical schools in this country. In a recent year, 13,000 men and women made 35,000 applications for admission, and 7,000 were enrolled in the first year class.

RESEARCH IN MEDICINE

Like all sciences, medicine today is an experimental science, deriving much of its knowledge from laboratories, where carefully planned experiments based upon sound hypotheses are carried out with meticulous care. Such experiments are *controlled*—that is, only one factor is changed at a time, in order to be sure that the result was due to that one factor and to nothing else.

Every medical school faculty is engaged in research in its laboratories, and several hundred organizations exist for medical research. Also, a large amount of research is constantly being done in the allied sciences (e.g. chemistry, biology, physics) which is of use to medicine. All scientific research is published, in order that other scientists may repeat the experiments and prove or disprove them. Research in medical science has been particularly favored in having large funds available from such sources as the Rockefeller Foundation. This and other foundations in recent years have contributed millions to the welfare of mankind in this way. No other branch of learning has been so well endowed.

One of the main methods of research is that of animal experimentation. This method is carried on with due regard for the sensibilities of the laboratory animals, as anyone can learn for him-

self by visiting medical laboratories. Yet many people who know nothing about the methods in use assume that animal experimentation involves cruelty, and are opposed to it. A physician who learned that a friend of his was about to appear before the Legislature of his state to oppose this type of research (wrongly called vivisection) asked him if he would be willing to read a book before he made his speech. The man consented, and the physician gave him a huge textbook of medicine in which he had crossed off everything that had been learned as a result of using animals in research. There was so little left of the book that the opponent of animal experimentation was convinced that this method is absolutely essential to the welfare of mankind, and he also became convinced by a visit to a laboratory that the methods of science are humane.

Many of the greatest discoverers in medicine have given their own lives in their research. Among them may be mentioned Lazear, who died as a result of volunteer exposure to yellow fever, in the experiments that finally banished yellow fever from this country; Holznecht, who died from X-ray injuries to which he voluntarily exposed himself in order to study these rays; and Noguchi, who died of yellow fever while hunting for the germ in its native haunts in Africa.

As an example of whole-hearted interest in medical research may be cited the case of Dr. Edward Francis, of the United States Public Health Service, who, during his work at the National Institute of Health exposed himself voluntarily and took tularemia, Rocky Mountain spotted fever, undulant fever, and relapsing fever.

Many workers in medical research have been young men who lived to see their discoveries lauded the world over. This is the case, for example, with those who discovered insulin; one of them, Banting, was knighted by the British government for his achievement.

One of the greatest honors that can come to a physician is to win the Nobel Prize for Medicine. Under the will of the philanthropic Swedish inventor of dynamite, five prizes are awarded yearly—for medicine, physics, chemistry, idealistic literature, and achievements in the interests of peace. The prize of 1939 was awarded to Gerhard Domagk, M.D., of Elberfeld, Germany, the discoverer of prontosil, the first of the group of drugs to which belong sulfanilamide and sulfapyridine.

In 1939 the United States Post Office Department announced that it would shortly issue postage stamps memorializing thirty great Americans, among them two physicians. One of these is

Major Walter Reed, of the U.S. Army Medical Corps, who in 1900, with Lazear, Carroll and Agramonte, demonstrated at the risk of life that yellow fever is spread by a particular kind of mosquito, and thus paved the way for ridding the western hemisphere

FIG. 83.—The five physicians who signed The Declaration of Independence: Lyman Hall, Georgia; Oliver Wolcott, Connecticut; Matthew Thornton, N. H.; Josiah Bartlett, N. H.; Benjamin Rush, Pa. (Copyright 1939, Menley & James, Ltd.)

of this disease which had invaded the eastern part of the United States ninety-five times, and had cost tens of thousands of lives.

The other of the two to be memorialized on stamps is Dr. Crawford W. Long, a general practitioner who first used ether as an anesthetic for a surgical operation, in the small rural town of Jefferson, Georgia, in 1842.

This country has had its share in contributing to the sum of medical knowledge. As one of the leaders in medicine has com-

mented, "Many of the great and significant advances in medicine which have been made in the past 15 years—the vast majority of them at least—have come from the medical profession of the United States."

MEDICAL PRACTICE

The majority of physicians are general practitioners—that is, they utilize medical knowledge in general among patients of all sorts. They have had training in all branches of medicine, and because of the wide variety of experience they obtain, they become very adept in diagnosis and resourceful in treatment. The breadth of their knowledge is to be contrasted with the depth of that of the specialist in a narrower field. Neither can be said to be more important than the other; they supplement each other in providing the public with medical care.

SPECIALISTS

It is reported that in ancient Egypt specializing was carried to such an extent that one of the Pharaohs had a specialist for the right eye and another for the left. Herodotus, in writing of Egypt, relates "Each physician deals with one malady, not more. And the whole place is full of physicians. Some are established as healers of the eyes, others of the head, others of the teeth, others of the region of the belly, and others of internal complaints."

Throughout history, the idea of limiting one's interest to one particular part of the body, or to one particular disease, appealed to physicians. But there came a time, after much had been learned about the body, when it was seen that every part is related to every part, and that a good physician must be acquainted with the whole. For several centuries there were comparatively few specialists among physicians. In fact in our country up until nearly the twentieth century, the vast majority of physicians were general practitioners. Since then, gradually specialism has again developed, but a different sort from that which prevailed of old. The modern specialist is a general physician first, and then a specialist.

There are several good reasons why it is desirable that some of the physicians should specialize. First, so much is now known that no single physician can keep fully posted on every branch of medicine. Second, there are so many techniques in diagnosis and treatment that no single physician could become adapt and pro-

ficient in them all. It is desirable that some physicians should obtain the utmost skill and have a great deal of experience in some of these special fields. Third, the necessary equipment to do all the work necessary in all the fields would be too costly for each physician to own unless he were going to use it often.

In this country, there exist twelve Boards, and two affiliate Boards, each of which attends to the certifying of physicians who wish to be recognized as specialists in a particular field. To be certified by one of these Boards a physician must have had the regular training of all physicians, and in addition must have had not less than three post-graduate years of training in his special field and two additional years of study and practice, and, finally, he must pass the Board's examinations.

The following branches of medicine are at present recognized as suitable fields for the certification of specialists.

Internal Medicine
Surgery, with its two affiliated specialties,
  Anesthesiology
  Plastic Surgery
Orthopedic Surgery
Pediatrics
Obstetrics and Gynecology
Ophthalmology
Otolaryngology
Dermatology and Syphilology
Psychiatry and Neurology
Urology
Radiology
Pathology

In December 1939, the Advisory Board for Medical Specialties published a "*Directory of Medical Specialists*" listing approximately 14,000 certified specialists. Copies of this volume are on public library reference shelves.

Internal Medicine.

Technically, internal medicine comprises everything that is not surgical. Practically, it usually excludes the various other specialties that have been mentioned.

The specialist in this field has devoted much time to the study of the internal organs—the heart, lungs, digestive tract, liver and gall bladder, etc.—and to the various disturbances of normal physiology and chemical conditions in the body. His work goes beyond that of the general practitioner not in its field, but in the

special knowledge, the detailed diagnostic methods and the experienced discrimination he is able to bring to bear on the more rare and puzzling problems. Even within this specialty, some physicians will become especially interested in one branch and some in another. By their colleagues, some are recognized as heart specialists; some, lung specialists; some gastroenterologists; etc.

Surgery.

Originally, surgery was not a branch of medicine. During the Middle Ages and for some time thereafter, surgery was performed by craftsmen who also acted as barbers. Their training was, however, on a high level. One of the first textbooks of surgery was written in 1380 A.D. by Lanfranco of Milan, who shows that surgeons of that time respected their profession and its obligations. He writes "A surgian muste haue handis weel schape, longe smale fyngris, and his body not quakynge." According to a more modern translation, "He must study in all the parts of philosophy and in logic, that he may understand scriptures; in grammar, that he speak congruously; in art, that teacheth him to prove his proportions with good reason; in rhetoric, that teacheth him to speak seemly." . . . "he must be true, humble, and pleasingly bear himself with his patients;"

At present, surgery is one of the most important and most highly specialized fields. More and more, the general practitioner of medicine is calling upon specialists in this field, rather than operating himself. Because of the elaborate technique of modern surgery, and the importance of experienced surgical judgment, this is as it should be.

Within the field of surgery, there are also many specialties. The American College of Surgeons has the biographies, it is reported, of 20,000 active surgeons. In the group are 6,000 general surgeons, 84 brain and head surgeons, 65 plastic surgeons, 8 skilled chest surgeons, and 12,600 young surgeons now in training in hospitals. The remainder are surgeons certified in special branches.

Orthopedic Surgery.

The orthopedic specialist is interested in diseases of the bones and the joints. He is a surgeon, but does not necessarily treat all his cases by surgery. In fact the orthopedic surgeon usually makes extensive use of mechanical methods such as braces, and of physical methods of treatment, such as manipulation, electrical current, etc. The American College of Surgeons lists approximately 500 orthopedic surgeons.

Pediatrics.

It is now recognized that the young growing human is a special study. Many conditions in the young are different from what they are in adults. In the case of some infants, it requires special knowledge to provide an artificial diet that will enable them to survive. Today many mothers are putting their children into the hands of a pediatrician as soon as they are born, with the aim of preventing them from having any unnecessary illness. This specialty is one that has made many advances in pre-clinical medicine.

Obstetrics and Gynecology.

Another of the branches of medicine that has made its greatest advances along the line of pre-clinical medicine is obstetrics. Childbirth is now more nearly the natural process it should be, owing largely to the pre-natal care of expectant mothers during the entire period of pregnancy. The trained obstetrician through such methods can forestall vast numbers of complications, and almost always bring both mother and child through the delivery in safety.

Gynecology, the specialty that deals with the diseases of the female reproductive tract, employs both medical and surgical methods. Specialists in this field should be relied upon for advice regarding any such matters that the general practicioner is unable to handle. They can often give help, for example, in persistent menstrual disorders that do not yield to customary hygienic or medical treatment.

Ophthalmology.

The work of the specialist in the eyes will be discussed in Chapter 38.

Otolaryngology.

This term means the science dealing with the ear and the throat. It includes also the nose and the sinuses. These specialists use both medical and surgical methods. General practitioners refer to them many patients requiring special diagnostic tests and special techniques in treatment.

Dermatology and Syphilology.

The disease syphilis is grouped with the diseases of the skin because of the fact that it presents an enormous variety of skin manifestations. However, dermatologists are not now the only physicians who are interested in the disease. The union of these two specialties came about before the other manifestations of syphilis were recognized as part of the disease, which followed the discovery

of the organism and of diagnostic tests for the disease. Today the field of the dermatologist includes all skin diseases, and the skin manifestations of constitutional diseases. Many dermatologists have still further limited their field to that of allergy.

Psychiatry and Neurology.

The specialists dealing with the diseases of the nervous system and the mind often specialize in either one or the other, but are trained in both. This is essential, owing to the fact that mental diseases are seldom diseases of the "mind" per se. The psychiatrist, to be a recognized specialist in this field, and to be relied upon by the public, must meet all the requirements as a physician and as a specialist in every aspect of brain and nerve disorders. Further mention of this matter will be made in Chapter 46.

Urology.

The urologist makes a special study of the urinary tract, both male and female. Often a specialist in this field adds also the study of the genital organs of the male, which are involved in many urinary disorders. In such a case, the physician is known as a genito-urinary specialist.

Radiology.

With the discovery of the use of X-rays in the diagnosis and treatment of disease, it was essential that the study of them be undertaken by specialists. The handling of such potent rays, and the taking and interpretation of X-ray plates, requires special experience. Every hospital has its radiologist, and also non-medical technicians who work under his direction.

Pathology.

The pathologist has studied in detail the tissues and fluids of the body, both in health and disease, and is able to make exact diagnoses by means of expert examinations of specimens. Reports from a pathologist are often necessary in making a diagnosis.

Anesthesiology.

From the time when ether was first used by Crawford Long in Georgia and by William Morton in Boston, and chloroform was first used in England, the science of anesthesia has come a long way. Up to about 25 years ago, these were the only two anesthetics in common use, and it was thought that almost anyone could safely administer them. Now it is known that administering an anesthetic is a matter for a specialist. Not only have many new methods

developed, but also a great many new anesthetics, each particularly suitable for given types of individuals and operations. One of the newer methods is injection of the anesthetic into the spinal canal. Also, many new chemicals have been found that aid in promoting insensibility, and thereby reduce the amount of anesthetic required. Local anesthesia has advanced as much as has general.

Plastic Surgery.

During the World War, this branch of surgery developed methods for reconstruction of injured areas, to give them the same form and function as before. The term plastic connotes form. Since then, plastic surgery has become a recognized specialty. The certified plastic surgeon does not as a rule operate purely for making persons more beautiful. He is called upon to perform operations that without his special skill might be disfiguring (e.g. the removal of growths from the face), to restore structures that have been injured by disease or accident, not only so that they look better but also so that they function better. As would be expected, many charlatans have arisen in this field, operating without the necessary skill, and taking huge fees from the hopeful for services that may make the condition worse rather than better.

In addition to the special fields just mentioned, the American Medical Association recognizes several other special fields among which may be mentioned: preventive medicine and public health; gastro-intestinal diseases; and proctology (diseases of the rectum).

DIAGNOSIS

Times have changed since the ancient days when physicians made their diagnoses by studying the stars or the way the numbers fell, or placed a patient at the crossroads, as was done in Chaldea, hoping that some passer-by might recognize the symptoms, and suggest a cure.

Times have even changed tremendously in this century, since the days of the "horse-and-buggy" doctor. In fact it is only in the past 50 years that the physician has had much more than his five senses to aid him in diagnosis. To be sure, the stethoscope was invented in the 19th century by a Frenchman, Laennec, who noticed that sounds were augmented when they came through a tube. But the stethoscope did not become popular at once. Instead, the physician continued until nearly the 20th century to put his ear directly on the chest when he felt the need of hearing the sounds within it.

Today, the physician has scores of aids for his five senses. In addition to the stethoscope ("chest seeing") he has dozens of other scopes: the ophthalmoscope, with which to look into the interior of the eye; the laryngoscope, with which to examine the larynx; the bronchoscope, cystoscope, etc. Many of these are used with reflected light so as to illuminate interior parts. One of the newest implements is the gastroscope, whereby the interior of the stomach can be seen, and, by means of an ingenious tiny camera, be photographed. All the scopes serve not only to give views of parts of the body, but also to make possible the application of treatment through

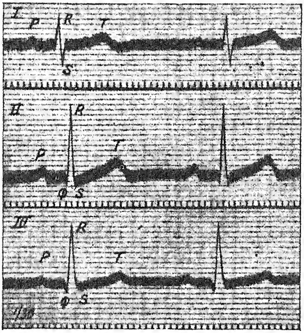


FIG. 84.—Typical electrocardiograms. (Winton and Bayliss "Human Physiology.")

them, to exactly the spot where it should go, and even for the removal of growths through them.

Another important diagnostic aid is the X-ray and the fluoroscope. By the latter a "moving picture" of what is going on can be seen with the individual behind a screen; by the former this view is recorded on a plate or film, for further study. By taking these photographs in a particular way, a stereoscopic view may be obtained, which gives perspective and the sense of depth. X-rays and the fluoroscope are particularly valuable in outlining the bony tissues, but they are now widely used for soft tissues too, since opaque substances or air can be injected into certain cavities so that the organs appear in contrast to their surroundings. This method is used in examining the digestive tract, the gall bladder, the cerebral and spinal cavities, the kidneys, the bladder, and even the lungs.

The examination of the heart is today greatly aided by the use of the electrocardiograph, a machine that makes a record of the heart beat, which often gives conclusive evidence regarding its health. If necessary in special cases, the sounds heard through the stethoscope can be radio-amplified.

No physician today would care to attempt the practice of medicine without the aid of numerous laboratory tests. To make a diagnosis, and to check the progress of an illness, the physician must usually make use of some of the following tests: *chemical*, of the various secretions and excretions, and of the body fluids (blood, spinal fluid, etc. withdrawn from the body by special instruments); *bacteriological*, of secretions, excretions, blood and body fluids; *pathological* (of tissues, such as those suspected of being cancer or otherwise abnormal); and *physiological* (tests of the function of the liver, kidneys, heart, and even the brain; of the total metabolism; etc.).

As is always the case, the experience of the physician making tests is the main factor in accuracy of diagnosis. All tests must be interpreted in the light of past experience with the same test, and also by comparison of the findings from various tests. Therefore the laboratory work done on a given case is reported not to the patient, but to the physician, who makes his report to the patient after he has weighed all the evidence.

TREATMENT

For the sick person in olden times, the treatment was almost certain to be medicine of some sort. Today a wide variety of other treatments are available as well. The recognized treatments all come under six headings: medicines, surgery, physical agencies, biological products, hygienic regimen, and psychotherapy.

A. Medicines.—The term pharmacology means literally the "science of magical remedies." Ancient as the word is, the hope that medicine will work magic is ever new. And as a matter of fact some medicines do—sometimes. When prescribed by a physician who knows what he can expect in the way of results, the possibilities of making changes for the better are very great. From year to year they become even greater. The most recent addition to the valuable drugs are the eight drugs of the sulfanilamide group, each having one or more trade names. These drugs are effective in the treatment of 33 bacterial diseases, but unfortunately not of the two virus diseases, the common cold and influenza.

For several other specific infections, certain specific drugs are used. For example, malaria is treated by quinine; syphilis, by arsenic, bismuth, etc. There is always the hope that all the infections may come under chemical control.

For a large number of non-bacterial diseases certain drugs have almost specific value in righting one condition or another. For example, some of the drugs acting upon the heart, the respiration, the blood pressure, the nervous system or the blood-building system will often apparently "work miracles." But these drugs must all be used only in the particular condition that calls for them, or they will do great harm. Diseases and ailments are not matched up as some laymen suppose—this drug "good for" that ailment. If they were, anyone could practice medicine.

In general, the action of a drug is either to stimulate a given function or to depress it. Some drugs are given to change a chemical condition in the body. Others are used to allay pain and discomfort.

Many of the drugs now most widely used are of recent origin and are manufactured synthetically. Among these are the derivatives of coal tar and of aniline dyes. They have replaced some of the older drugs made from herbs, but others such as digitalis (foxglove) remain in the honored position they have long occupied. A few of our present drugs data back to aboriginal times—for example, quinine, which was in use by the Aztecs and Incas.

Drugs are given by mouth, or, when quicker action is needed, by injection under the skin (hypodermic) or into a muscle, or into a vein (intravenous), or elsewhere.

Medicines are applied to the surface of the body (skin or mucous membranes) usually to cleanse; to disinfect (e.g. wounds); to soothe (e.g. sunburn); to stimulate (e.g. scar formation); or to change the amount of secretion, either to increase it or decrease it (e.g. sebaceous secretion of the scalp). Some medicines rubbed into the skin are absorbed, and produce constitutional effects (e.g. mercury as used in the treatment of syphilis).

B. Surgery.—Because it has so long been a special field of interest, surgery early arrived at a high degree of mechanical effectiveness. It is clear that even brain surgery was skillfully performed thousands of years ago. However, in those days infection caused a high surgical mortality rate. A new era began with Lister, who was the first to apply Pasteur's bacteriological discoveries in the operating room.

The present excellent results of surgery are due largely to aseptic methods—that is, operating with sterile instruments and with

everything that touches the area of the operation sterile. Further advances have come through the long training surgeons now receive, and their limiting their work entirely to surgery. Also, as mentioned, the advances in anesthetics make for greater ease of operating and greater safety for the patient.

Surgical operations are performed for a number of different reasons. A considerable proportion are for the removal of parts of the body that are a menace to health (e.g. appendix, tumors, etc.). Often operations are for the removal of accumulated fluid, such as pus from an abscess, or other offending material, such as gall stones. Surgery is also used to join separated parts, as in hare lip, or to separate joined parts, as in adhesions. It includes the reduction of dislocations and the setting of fractures, the transplantation of tissue, the repair of damaged tissue, and many other corrections of structural defect or functional disability.

Fig. 85.—Lord Lister (1827–1912). (Hoffman-LaRoche.)

When surgery is needed, nothing else will serve as well. A large proportion of operations are done because not only health but life itself is threatened without them. Operations are usually successful if the patient has obtained and acted upon medical advice promptly enough. No one need unduly fear an operation recommended and performed by a certified surgeon.

C. Physical Agencies.—First on the list come X-rays and radium, both of inestimable value in treating cancer. X-rays were discovered in 1895, by Roentgen, professor of physics at Wurtzberg, and radium by Pierre and Marie Curie in Paris in 1898. Whether the cylotron, recently invented by the physicist, E. O. Lawrence of the University of California, will prove even more effective remains to be seen. The new radiations are being tested by John Lawrence, the physician brother of the inventor.

Various other radiations are of medical value, among them the familiar ultraviolet rays of natural sunlight and the artificial rays produced by lamps, first given to the world by Finsen in 1895.

Of importance today are the short and the long radio waves used to create heat in deep lying parts. Diathermy machines are widely used in hospitals and physicians' offices. They are helpful to the extent that heat is helpful. Often the results are spectacular.

As is the case with all such apparatus, the greater the power to help, the greater the power to harm if not used with scientific precision.

Heat has long been recognized as an aid to healing and relief of pain. Recently its use has been extended, in the form of fever therapy, which was introduced to the medical world by Wagner-von Jauregg in 1917. In ancient Egypt, epilepsy was treated by giving the patient marsh fever. Von Jauregg discovered that those in the late stages of syphilis could be helped by giving them malaria. Later, another fever-producing disease was used, sodoku. More recently machines have been devised to apply short radio waves so as to raise the temperature of the whole body above the level of any ordinary fever. This method has been tried in treatment of fifty or more diseases, and has been found effective in ten.

In contrast to fever therapy, there has recently been experimentation with refrigeration, which seems to indicate that prolonged lowering of body temperature may be helpful in relieving pain in certain conditions.

Included under the heading of physiotherapy are: the use of any electric current; any heating or cooling device (such as those mentioned, or baths, etc.); any mechanical apparatus (such as supports and braces, the "iron lung," etc.); and any manual means such as manipulation and massage. As research proceeds regarding the forces of nature, it is likely that physics will take rank with chemistry as a source of medical treatment.

D. Biological Products.—Among the remedies obtained from living things, several have already been mentioned (e.g. vaccines and sera, bacteriophage, the extracts of endocrine glands, and the allergens). Included in the list are various tissue extracts (e.g. liver). In general, they serve to stimulate the body cells to specific activity of some sort (e.g. antibody formation) or to replace a substance normally present (e.g. thyroid extract, liver extract). The range of these products is constantly increasing. Some of the most striking advances in medicine are being made along these lines.

E. Hygienic Regimen.—Whatever other treatment is needed, the sick person usually needs to make certain changes in his usual way of living. For example, he may have to remain in bed, take a special diet, sleep more, etc. In some diseases, these details of hygiene are the main curative method (e.g. in tuberculosis, the important thing is rest). In most diseases, what the physician advises about habits of living are quite as important as his prescription for medicine or his use of any other form of treatment.

F. Psychotherapy.—Many disorders have their origin partly or wholly in the state of mind, i.e. they are psychogenic (*psycho*, mind; *gen*, origin). Mental factors as well as somatic (bodily) factors in disease must be recognized and treated. Often the use of psychotherapy falls within the scope of the general practitioner, who studies the patient's mental attitude in order to influence it for the better; but in some cases, the services of a specialist in psychotherapy (a psychiatrist) are required.

MEDICAL FORCES

Personnel.

In the United States there are approximately 135,000 physicians, or 1 to every 1000 in the population. The proportion is

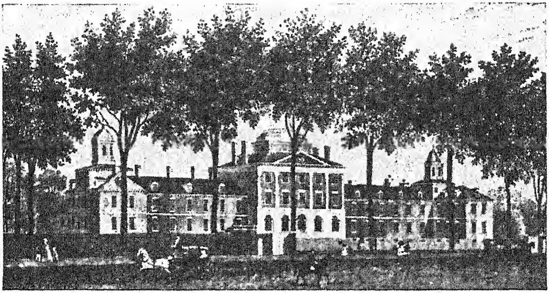


FIG. 86.—Pennsylvania Hospital, Philadelphia—first hospital in America. Founded in 1752. Building erected 1756. (Menley, James Company.)

higher than in other countries; in some of the most highly developed European countries the ratio is 1 to every 3500. Few of our communities are without a physician.

In addition, there are said to be 1,250,000 members of other professions engaged in full time work for the sick. These other professions have either developed enormously since 1900 (e.g. the annual number of nursing graduates has increased from a few hundred to over 20,000) or have originated since then (e.g. the profession of the medical social worker, laboratory technician, dietician, physiotherapist, etc.).

The figure given above does not include the large number of those professionally engaged in preventive work.

Hospitals.

Since 1900, the number of registered hospitals has increased nearly sevenfold, from about 1,000 to nearly 7,000, with a total of 1,000,000 beds. Also, there are countless small private hospitals, nursing homes and sanitariums. A hundred years ago there were only a few dozen hospitals in the entire United States. The first hospital in the United States, opened February 10, 1752, in Philadelphia, is shown in Fig. 88.

Of the total number of hospitals, about one tenth, 734, are approved by the American Medical Association as suitable for interneships for medical graduates, and 518 for residency and fellowships for training in the medical specialties.

The same organization has computed that only 13 of the 3,073 counties in the United States (2,000,000 population) are more than 30 miles away from a good general hospital, and that in 8 of these counties the population is less than 5 per square mile. The National Health Survey, however, reported that more hospitals are needed.

Many of the hospitals (over 4,000) are privately owned and financed (by medical schools, religious groups, philanthropic organizations, etc.), and the rest are public hospitals, owned and operated by towns, cities, counties, states and the federal government. Of the latter, a large number are for the mentally ill.

It was reported that in 1938 a total of 9,421,075 persons, or 1 person in every 14, spent an average of 12.5 days in a hospital. The same report stated that 1,026,771 babies were born in hospitals in that year.

The number of clinics and dispensaries now totals nearly 10,000. In 1900 there were only 150 public dispensaries in the whole of the United States.

Chapter 15

PERSONAL USE OF PHYSICIANS

From time immemorial mankind has used physicians to give relief from suffering and if possible to banish ills. This is still the major use made of them. When people call upon doctors, it is chiefly for clinical medical work. The term *clinical* is derived from the Greek word *clinos*, meaning bed, but it is used to describe medical work with the ill, whether or not they are in bed. The clinical use of physicians is the subject under discussion in this chapter. The pre-clinical use of physicians—that is, for the care of health before sickness begins—is mentioned in Chapter 18.

Choosing a Physician.

In a community of any size, it should not be difficult to find a good physician. In fact, in a self-respecting community it is likely that most of the physicians are self-respecting, able, and competent.

Good physicians are far more common than poor ones, because medical education is well standardized. Medical schools meeting certain minimum requirements as to subjects, hours, laboratory and hospital facilities, and the like, are ranked as Grade A. Graduates of such schools are similarly equipped as to their fundamental training, and they will be likely to have had similar additional experience, perhaps for several years, in hospital work.

Also, physicians must meet the requirements of the state in which they propose to practice, and be licensed by the state, before they are permitted to practice there. Each state gives examinations and issues licenses only to those who pass them. In states in which the examinations are open only to graduates of recognized medical schools, one may usually feel confident in employing any licensed physician.

To obtain information about physicians, inquiries may be made of persons of standing in the community, or the local hospital, or the board of health, or the local secretary of one of the national health organizations such as the Red Cross or National Tuberculosis Association, or a local college office, or the secretary of the local county medical society.

As for choosing the very best among a number of good physicians, that aim is usually futile. It leads one to fruitless "going the rounds" among the physicians, and giving none of them a real chance to be of service. In so far as is possible, it generally works out better to come near to the traditional standard of the "family physician," whose thorough acquaintance with his patient is invaluable.

Specialists.

When a specialist is needed, or thought to be needed, it is usually better to consult a general practitioner, first as to the need, and second as to the appropriate specialist. In many cases this saves both time and money and gives better results.

A physician who is a specialist does nothing to advertise that fact to the public. Instead, he acquaints other physicians of the fact that his practice is limited to a given field, thereby making his services available to the public through other physicians. Of course the fact that he is a specialist may become generally known, but not through any publicity on his part. If he makes mention of the fact at all on his sign, it will be in modest letters, not at all in the way of advertising. In many states, physicians' signs bear nothing but their names and degrees.

Quacks who advertise themselves as "specialists" in various disorders (e.g. Cancer Specialists) often succeed in misleading the public into thinking them recognized members of the medical profession. But by their very advertising they indicate that they are not.

Consultations.

In some cases, either a general practioner or a specialist may feel that two opinions are better than one, and may suggest a consultation. This does not necessarily mean that the illness is baffling, or particularly serious. It always does mean that the physician is using every care in the patient's behalf, and such care should be welcomed, rather than resisted.

Consultants make separate charges, and send separate bills. For a consultant to split his fee with a doctor who sends him a patient, would be ground for expulsion from most medical societies, with complete loss of professional reputation.

Changing Doctors.

A person is entirely free to choose any doctor he likes, and to dismiss him at will. When he goes to a second doctor in the community, he must be able to assure him that the first doctor has been

informed of the change, for medical ethics requires that no doctor should take another doctor's patients. This applies also to consultants. For fairly obvious reasons, changing doctors is not usually to be recommended.

As for physicians, they, too, are free to choose whom they will serve. Having assumed the care of a patient, they are bound to continue such care as long as the patient needs and desires their services, or until they have given due notice so that another physician may be obtained. Although not legally required to answer any calls, in emergencies physicians always feel it is their duty to respond if no other physician is at hand.

Confidential Relationships.

The medical tradition is that physicians shall consider everything they learn from patients and about patients during a medical consultation as strictly confidential. The law upholds that tradition. Consultations between physicians and their patients are held to be "privileged communications." A physician cannot be required to divulge them, although a patient can give him permission to do so. There is only one exception; according to law physicians are required to report to the board of health any case of communicable disease listed as reportable.

In institutions employing physicians, the understanding generally is that the heads of the institution are entitled to the information they have employed the physician to obtain (e.g. the results of physical examinations, or any matters affecting the welfare of the group or of the institution itself), but that the usual confidential relationship between patients and physicians maintains in regard to other matters.

Hospitals, Clinics, Dispensaries.

In all large cities and many smaller ones, there are opportunities to consult physicians practicing medicine in connection with public or private organizations. Clinics or dispensaries may be considered reliable when operated (a) by the health departments of the city or the state, in connection with general or special hospitals, or separately; (b) by medical schools; (c) by the well known national organizations; and (d) by private hospitals or private physicians of repute.

Services at public clinics and dispensaries are usually either free or charged for at low rates. Many of the modern clinics are established entirely for medical purposes rather than charitable (e.g. diagnostic clinics for venereal disease, or cancer), although it is

usually expected that those who can do so will employ private physicians.

Private clinics may be measured by the standing of the physicians conducting them. Some are of international repute; in these, fees are adapted to individuals.

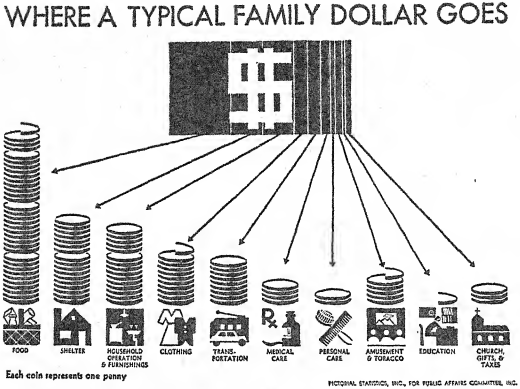


Fig. 87.—(From "How We Spend Our Money," by Maxwell S. Stewart, published by the Public Affairs Committee, Inc., New York City.)

Medical Fees.

In any given community, the fees of all the general practitioners will usually be the same, and specialists' fees will vary according to the individual physician.

If a patient is unable to pay a physician's full fee, he will usually find that an adjustment can be made. The physicians in the United States annually give $365,000,000 worth of free service. They do this partly for humanitarian reasons, and partly because they are professionally interested in every case and take satisfaction in solving medical problems. Most physicians are very generously inclined, especially toward patients who give full cooperation, if not full fees.

When to Consult a Physician.

This question is easily answered in the case of students in colleges that require the reporting of all illness and injury. They need

not decide whether they really need a doctor or not—but merely whether they are ill or injured.

In general, whenever that question arises it should be answered in the affirmative, for a person who suspects that perhaps he may be ill usually is ill, in the sense covered by the college rules—although perhaps not downright ill in the sense the general public uses the term.

When such inclusive rules exist about reporting illness, the student should look upon himself as "ill" (*a*) if he has to miss classes, or even a single class; (*b*) if he feels pain or discomfort, even though he is able to go about as usual; (*c*) if he lacks his usual vigor and sense of well-being; (*d*) if he notes any changes in his body, such as a rash, swelling, inflammation, etc.; (*e*) if he has had an accident, whether or not it seems to have caused much injury; (*f*) if he has been exposed to a communicable disease and is thus, perhaps, in the incubation stage of illness.

Others than college students would do well to gauge the need of medical advice by the same criteria. To be sure, many ailments do subside, but the layman has no way of knowing which will do so and which will progress while he delays action or tries to treat himself.

The Meaning of Symptoms.

Most symptoms do indicate sickness of some sort, and should be taken to mean that until proved otherwise. Two points are of importance. First, symptoms are by no means always in proportion to their cause. It is well known, for example, that the early symptoms of cancer and of heart disease are rarely annoying enough to drive a person to see a doctor about them. These serious diseases will continue to be the leading causes of death until people become more wary about waiting for symptoms to pass off.

Second, symptoms may subside but the ailment not. This fact is commonly recognized regarding toothache, which may wear off after a time, leaving behind it the abscess that was forming while the ache was present. It is equally true of many other symptoms.

Importance of Prompt Action.

As has been repeatedly indicated in this volume, all diseases, without exception, are vastly more amenable to treatment at their beginning than after they have gained headway. This point needs no further emphasis; but two other points do.

First, even if cure is possible when treatment has been delayed, one may have paid rather heavily for it in lost time and in the cost of

medical care. There would seem to be no reason for having a long, expensive illness when one could have a short, inexpensive one.

Second, if symptoms are not heeded when they first appear, they may become urgent at an inopportune time, when medical care cannot be immediately obtained, or in circumstances when medical treatment is difficult. Emergencies may be accidental and not preventable by foresight, but often they indicate mismanagement at some point.

Mistaken Expectations.

There is a tendency to expect either too much or too little of medical science. Some have so much confidence in it that they expect it to be able to outwit natural laws. For example, a student recently consulted a college physician about "reducing"; she weighed 150 pounds on a Monday and she wished to weigh about 115 pounds by Saturday evening. Another student had had a bad attack of ivy poisoning, self-treated for four days, and wished the physician to cure it before she went away for a week-end party the following day.

Others have too little confidence. If they go to a physician at all it may be with the idea that possibly he may be able to make a lucky guess or hit upon some remedy by chance.

The intelligent and discerning person expects of physicians what physicians are trained to give—the applied wisdom of medical science—no more, and no less.

What to Expect of Physicians.

When one consults a physician it is justifiable to expect that he will be able to make a *diagnosis*—that is, to discover what is the matter; to give a *prognosis*—that is, to estimate the probable outcome (whether recovery is likely, how long the illness will last, etc.); and to *prescribe treatment*—that is, to write a prescription for drugs, or give or recommend some other form of therapy, or advise regarding measures of hygiene.

Sometimes a diagnosis is unmistakable almost at the first glance, but more often it does not reveal itself thus, but must be sought through examinations and tests of various sorts. The physician has in mind not only making sure that a given disorder is present, but that others are not. His judgment will be suspended until he has all the evidence he needs, although he may give a provisional diagnosis earlier.

When a physician expresses himself definitely regarding either diagnosis, prognosis or treatment, either at once or after delibera-

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When a physician expresses himself definitely regarding either diagnosis, prognosis or treatment, either at once or after delibera-

tion, it is quite likely that he is right, for a physician risks his valued professional reputation if he makes any but carefully weighed statements.

Usually, a patient may expect his doctor to tell him the exact truth about his condition, or as much of it as he can understand. Many physicians spend a good deal of time explaining matters to patients, in order to relieve their minds of fears, and to secure more complete cooperation in treatment.

Fig. 88.—A doctor examining a patient, a dwarf. Second century B.C., British Museum, London. (Courtesy Ciba Co.)

A Good Patient.

From the physician's point of view, a good patient is one who respects medical science in general; who respects his own physician; who tells all the facts regarding the complaint for which he consults his physician, answering all questions fully, and holding nothing back; and who is willing, at least for the time being, to surrender his own preferences to the medical judgment of the physician.

To withhold the truth from one's physician is like handing him a picture puzzle with some of the pieces missing. The *anamnesis* (history) of an ailment may include many matters that to the patient seem irrelevant, but to the physician are important.

As for following the physician's advice, the patient is safe in assuming that everything that is advised is of equal importance. He has no way of knowing whether it would be safe for him to disregard any of it.

All too often, patients who are given a prescription for medicine will have it filled and take it religiously, but at the same time they may completely ignore advice in regard to daily regimen. As has already been stated, the body tends to cure itself of many ailments if it is given any reasonable sort of chance, and when a physician suggests modification in habits it is because he believes them to be necessary in order to give the body its best chance. Celsus, during the first century, stated that with dropsy it was easier to bring about the recovery of slaves than freemen, because it was easier to enforce thirst and hunger on the slave.

A person who knows something of how the body works usually makes a better patient than one who is entirely ignorant of such matters. On the other hand, the important thing is complete confidence in the doctor, and willingness unreservedly to "put one's self into the doctor's hands."

Chapter 16

CULTS AND QUACKERY

Long ago in Rome (533 A.D.) in the "Digests" prepared under the direction of Emperor Justinian, a distinction was made between regular physicians and quacks.

The medical profession was defined as one of the free professions. With other professional men—rhetoricians, grammarians and surveyors—regular physicians were granted certain exemptions from military and political duties in recognition of their public service. Irregular or pseudo-physicians were understood even then to be a danger to the public, and were granted no exemptions.

The practice of medicine at that time included general practice, and also certain specialties such as obstetrics and ophthalmology. Examinations were held by the state, to ensure that only able physicians should have the right to practice. The state made use of legislation, just as today, to uphold a high standard of medical practice. The regulations particularly mentioned and outlawed all those who attempted to cure disease by any sort of magical or mysterious means. The regular physician used means in accord with the science of the time.

Nevertheless, throughout the ages, and today as much as ever, man's credulity has been one of the chief obstacles in the path of health. The great physician Sir William Osler stated that "In all things relating to disease, credulity remains a permanent fact uninfluenced by civilization or education."

Unbelievable as it may seem, in the United States and Canada "healing" cults flourish more than in any other countries of comparable standards of popular education. It is estimated that "doctors" of the organized cults are in the ratio of one to every four scientific physicians. In addition, there are innumerable unorganized groups and separate individuals practicing this or that peculiar method of treating disease.

This means that large numbers of people by their own choice are not receiving scientific aid when ill. How can that be? Possibly because they are incapable of using reason on health matters, as Osler suggested; possibly because their reasoning is at present

founded upon misconceptions regarding what scientific knowledge is and how it is obtained.

Scientific Knowledge.

To many people, "one man's opinion is as good as another's"—the cultist's as good as that of the man of science. The point is that the opinion of the man of science is not one man's opinion, but the consensus of opinion of vast numbers of scientists, who have made countless experiments and observations that prove the opinion to be scientifically sound. This is true of all sciences, including medical science.

Medical science is derived largely from laboratory experiments (in chemistry, physics, biology, and other sciences, including the specifically medical sciences), and from repeated clinical observations. It comprises many facts that are demonstrably true—that any competent and impartial person could prove for himself, just as he could prove that $9^3 = 729$ if he knew how to compute arithmetically and had no prejudice in favor of some other answer.

When medical science learns a new fact, it usually comes about in this way. First, someone discovers something which he believes to be a fact. He publishes his findings in a scientific or professional journal, so that it will be read by others in the same line of work. Other workers then repeat the experiments, and they too report their findings, whether they agree with the first findings or not. If they do not agree, experimentation continues, and the matter is said to be a controversial one.

When and if they all agree, it means that large numbers of scientists have performed the experiments themselves, and have satisfied themselves of the truth of the observations and the conclusions. It is not until then that the original finding is entitled to be called a scientific discovery—a scientific fact. Thereafter, when an individual physician holds that fact to be true, it is not his own personal opinion, but the opinion of science as a whole—of all individuals entitled to an opinion on the matter. It stands on its merits alongside all other known facts of science.

Some of the facts of medical science have been established for centuries. Among these are the major facts regarding the gross structure of the body. These facts belie many cultists' theories. For example, it is a fact, not a theory, that the bones of the spine are so built that they cannot move in the way some of the cultists say they do. All that anyone need do to convince himself of that fact is to

examine the vertebrae with the same technical care as do men of science.

Some of the facts of medical science are newly established, but just as valid as if they had always been known. For example, it is a fact that some diabetics absolutely require insulin in order to live. Recently in the state of Washington a cultist was convicted of manslaughter because he did not accept that scientific fact and caused the death of one of his patients by substituting spinal manipulations for insulin. This cultist was a member of a group claiming, in many states, equal rights with physicians.

Non-scientific Claims.

The cultist does not use the methods of experimental science. He holds opinions not held by science, and not demonstrable to the scientific world.

The ideas of the cultist are based either upon nothing at all except an inspiration as to a way of making the gullible pay money; or upon something he ignorantly believes to be true.

It must be supposed that often the cultist is sincere in believing what he asserts—but the sincerity is not what counts. The important thing is the evidence on which it is based. Usually his convictions have been based upon one happening, or a few happenings, in which apparently good effects followed certain treatment. From these few observations, he has generalized, and formed a theory that the same good results will always follow the same treatment.

For example, a person perhaps has been ailing and has gone to a doctor who advised him regarding his diet and about taking exercise, and did not give him any medicine. His health improves. But instead of reasoning that diet and exercise and no drugs were what he had needed in his particular condition, he reasons that that is what everybody needs for any illness, and that nobody needs anything else. Thereupon, sincerely impressed with the value of hygiene, he establishes a cult, decrying the use of medicines and raising hygiene to a pinnacle of omnipotence.

Much of a "health" cult's publicity would sound entirely plausible to those who know that medical science does advocate most strongly a correct diet and the right amount of exercise. The fallacy in generalizing about the matter might not be apparent. Medical science particularizes: *sometimes* improvements in hygiene are what is needed, and sometimes something quite different.

The health cultist's unwarranted respect for "hygiene" may lead him into grievous errors. Realizing that medical science does indeed respect the body's power of defending itself to some extent against infections, he may argue that the body can defend itself against any and all infections. There are many cults that insist that the use of biological products to produce immunity either for prevention or for cure is quite unnecessary. They speak of "tainting the blood," and argue against it on the ground that the body itself is able to produce all the immunity it needs if "vitality" is sufficiently high. This simply is not true. The cultist has taken part of the truth and made it into a whole truth. It would be interesting to know whether such a cultist would stand by his assertion to the extent of exposing his own child to diphtheria, and running the risk of watching it strangle to death without antitoxin.

It has taken centuries of unremitting labor for medical science to find out some of the laws governing human life. And it takes years for the student of medicine to become familiar with them. Yet the cultist blandly ignores them—and what is worse, defies the very principle of scientific investigation upon which all our knowledge and much of our civilization rests.

Changes in Scientific Opinion.

To justify its divergence from scientific opinion the cultist may argue that science is not fixed, that it changes its opinion, that what it does not believe today it may believe tomorrow.

These, again, are half-truths distorted. Certainly it is true that science is not fixed in the sense that it is stationary. Of course science does add to its knowledge, moment by moment. But it is quite unwarranted to imply that nothing of scientific knowledge is fixed, or that it will ever adopt ideas already demonstrated to be totally illogical and contrary to all known fact.

For example, it is merely ridiculous to suggest that science will ever accept the idea that all diseases are due to any single cause, such as pressure upon spinal nerves. Too many separate causes have already been proved to exist.

Science will change, certainly; but not by anybody's guesswork or idle inspiration. To the layman the term discovery suggests a chance happening, a coincidence, a happy thought, or a bright idea. Usually scientific discoveries are not sudden and unexpected. Although they may come upon the world suddenly, behind their disclosure have usually been years of painstaking labor scarcely more dramatic than drudgery. Workers toil on, making one experi-

ment after another, in orderly fashion, each based upon what is already known and upon a sound hypothesis of what might be learned.

Exploitation of Scientific Knowledge.

Some charlatans take up a new discovery of science and exploit it for their own gain. Whereas the regular physician would use the new discovery in its proper place in the care of individual patients, the charlatan attempts to make large numbers of people think they need that sort of treatment at once, and to believe that he is the only one who can administer it. Unfortunately, even some physicians have been so self-seeking as to do that. While not actually advertising themselves, they have permitted popular writers for the magazines, in need of sensational material, to attribute to them the most extraordinary "cures" by means which, upon investigation, turn out to be methods no different from those in use by physicians the country over. By not denying the remarkable powers that others attribute to them, it would appear that they appreciate the financial value of the misleading free advertising they receive.

Enlightenment of the Public.

The claims of some charlatans are so utterly beyond reason that there is nothing for science to do but ignore them. Such, for example, is the case with the claims that any disease can be diagnosed at a distance by examination of a lock of hair. A woman in a cultured Eastern city made nearly $200,000 by that method recently before she was convicted of using the mails to defraud.

Occasionally, however, there will be something in a current fad that causes it to appeal even to intelligent people, and in such a case it is necessary to publish explanations of the fraud. Such has been the case in recent years regarding various uses of electrical currents. These are rather mysterious to many people. They see electricity apparently preforming miracles, and on that account are more easily led into believing that perhaps it will do hitherto unsuspected wonders in curing the human body. Naturally it is difficult to make clear why medical science uses certain electrical currents for certain medical purposes but calls the quack's use of them hocus pocus. Therefore the electrical fakes continue.

Similar need for enlightening the public recently arose in regard to a diet which became a nationwide fad—that of taking only one of the foodstuffs at a meal. This appealed particularly to the educated person who knew that the digestive tract does indeed produce different enzymes for the digestion of the three different foodstuffs.

They thought it quite possible that science had somehow missed discovering the advantage of offering the digestive tract only one foodstuff at a time. The answer, first, is that it is practically impossible to limit meals in that way, since virtually all foods except sugar contain more than one foodstuff. And in the second place, it has long been known that nature's sequence in the digestion of foodstuffs allows for the complete digestion of all of them, whether taken together or separately. That some individuals did benefit by this diet is explainable on the ground that they needed to reduce their total intake of food, and did so while curtailing their meals in this fashion.

The Charlatan's Attitude toward Science.

Many of the cults and quackeries attempt to confuse the public as to their relationship with science. Some recognize that in explaining their methods and their "cures," the more they can make them sound like genuine science, the more will the educated be likely to join their following. Therefore many of the frauds perpetrated on the unwary have a distinctly medical sound.

If cultists have some sort of doctor's degree, and many of them have, they may try to convey the impression that it is a medical degree, or at least that it is virtually the same as a medical degree. If they have no degree, they may still call themselves "doctor," until the law catches up with them for practicing medicine without a license.

On the other hand, many of them stand outside medical science, and state the fact openly without the slightest embarrassment. Their claim is that they possess special knowledge not possessed by medical science.

Special Knowledge.

In view of the thousands of research workers in the medical sciences, and the diversity of their fields of research, it is highly unlikely that anyone outside the field of medicine should stumble upon anything that science had not. But if he did, what would he do about it? Certainly he would inform the scientific world of it, would permit it to be tested widely, and if proved beneficial would place it at the disposal of all physicians everywhere. Even the most self-seeking person would do so, for science and the world as a whole would pay in honor and in money for any discovery of value in treating ills or in saving lives. The fact that "special knowledge" is not disclosed leads to the logical conclusion that it would not stand the test of thorough investigation.

Mind Cures.

According to a recent count, there were thirty seven different systems of mind healing in this country, operating with a clientele of 10,000,000 people. Some of them deny the evidence of the five senses that material things exist, yet in all matters except disease they act as though they were quite aware of material things. For example, they seem to feel heat and cold, for they live in houses and wear clothing according to the temperature, they eat food, drive cars, and in other ways appear to appreciate bodily needs and to enjoy creature comforts. That these strangely inconsistent cults should attract so many followers is beyond explanation.

Other mind cures do not deny bodily existence or disease, but claim that all diseases are curable by mental means. This, of course, is not a fact—as anyone can prove who wishes to try the experiment. Recently a mother in California did so in the case of her child. After a physician had ordered the child to a hospital she called a mind healer instead. The child died of a ruptured appendix, and the mother was sentenced to prison. The cultist went free, as is usual in such cases.

It is true that body and mind are one, and that each influences the other strongly, but it is also true that some causes of disease are so powerful that they act regardless of the state of mind.

When recovery follows mental treatment there are three possible explanations. First, the illness may have been a psychogenic one—that is, the product of the state of mind. In such cases, setting right the state of mind means doing away with the illness. Many illnesses—even complete paralysis of the extremities, blindness, serious digestive disorders, and the like—in some cases have no reality outside the patient's mind. Psychotherapy is the scientific method of treating such ills. However, anything that changes the state of mind in the right direction may bring about a cure. Even the suggestion that the ailment is to be cured, if given strongly enough, will often do so.

Second, the illness may have been somatic (bodily), but one from which the patient would shortly have recovered in any case. Many diseases are self-limited, i.e. they tend to be cured by nature's processes of repair. If recovery occurred after mental treatment, it might logically be attributed to the treatment.

Third, the illness might have been one in which the outcome was doubtful unless the state of mind could be improved. The physician, or anybody else, who can arouse hope and confidence

in a patient will often stimulate flagging powers, perhaps enough to turn the tide toward recovery.

Superstition and Magic.

Sir James Frazer, the anthropologist, whose investigations throughout the world made him a leading authority, stated that "When we survey the existing races of mankind, from Greenland to

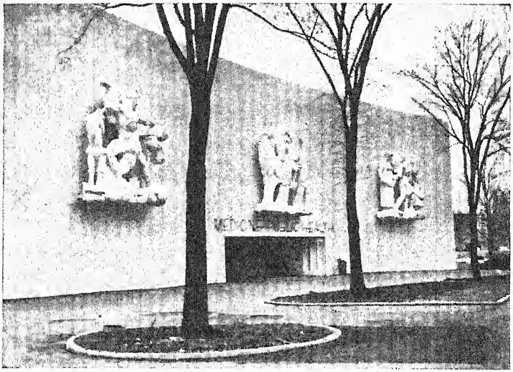

FIG. 89.—Entrance to Medicine and Public Health Building. New York World's Fair, 1939–40.

Tierra del Fuego or from Scotland to Singapore . . . there is a solid substratum of intellectual agreement among the dull, the weak, the ignorant, the vast majority of mankind . . . a belief in magic. Among the ignorant and superstitious classes of modern Europe it is very much what it was thousands of years ago in Egypt and India, and what it now is among the lowest savages surviving in the remotest corners of the world."

That this statement is also true for this country is borne out by the fact that the committee in charge of the Medicine and Public Health Building at the New York World's Fair in 1939–40 included an exhibit on Superstition in Medicine. It was stated that "hundreds of different varieties of hocus pocus are relied upon by literally millions of people."

Much additional evidence is also available. For example, a few years ago the occurrence of a crime in one of our most civilized states brought out the statement from a county official that "At least half of the 60,000 residents of the city of [county seat] believe in witchcraft. . . . And as for the county's rural population of 90,000, they not only believe in witchcraft, but guide the minutest details of their lives by it."

In the criminal case mentioned, the guilty individuals and the victim were all believers in witchcraft. The crime was committed in order to obtain possession of a manual of witchcraft written in 1819, and a lock of hair which was to be buried eight feet under the ground at the full of the moon, as part of the hex doctor's remedy to drive away a "spell" of sickness cast on one of the culprits by a witch.

This county is certainly unusual, yet as one of the newspapers stated at the time "In America are perhaps 200,000 professional priests and priestesses of Voodooism in its milder forms—crystal-gazers and fortune-tellers, using one system or another."

As another newspaper commented, "Among those who marvel that such conditions could exist in the twentieth century are many who believe that seven years' bad luck follows the breaking of a mirror; that numbers like '13' and '7' have an extraordinary effect on human destiny; and that breaking a chicken-bone has something to do with the fulfilment of wishes."

In a college class, the eighty students were able between them to give 14 popular ways of preventing rheumatism, among which were "carry a horse chestnut in your pocket," "wear a nutmeg on a string around your neck," "wear a silver ring," "cross your shoes at night," etc.

According to an editorial from the Journal-Lancet, "Man looks out on the world about him, clutching Science with one hand, anxious for its benefits, yet clinging firmly with the other to the superstitions of the ages. The figure of Samuel Pepys, famous diarist of the 1600's, walking home with a rabbit's foot in one pocket and a copy of Hooke's *Book of Microscopy* in the other, still stalks the pages of our daily lives."

Even the intelligent need to be on guard against expecting any dissociation of cause and effect. They, too, are not immune to fantasy, as in fairy tales when anything "might be." The danger is especially great in times of illness. As Frazer said, "In a civilized community the belief in magic is concealed beneath the veneer of education, and does not obtrude itself in normal life, but the veneer

cracks as soon as any strong emotion is aroused, and both pain and fear of death are potent causes for arousing such emotions."

A striking commentary on the love of magic is the fact that scarcely a newspaper in the country has failed to refer to the drug sulfanilamide as the "miracle drug." It appears that the more remarkable the triumphs of medical science, the more the results are credited to magic.

The Public Health Problem of Quackery and Cults.

There is no way of knowing precisely to what extent the failure to utilize medical science is a cause of disability and death. The mortality statistics do not state the kind of treatment an individual had received for the illness from which he died. The National Health Survey showed how many people were chronically ill, and how many of them were not under medical care, but it did not show how many had never had scientific medical care *nor wanted it.*

From the nature of things, it is beyond question that a large percentage of illnesses become chronic because individuals delay in getting proper treatment at the start—and perhaps more often than not, the reason for the delay is that they have been dallying with non-scientific treatment.

Since chronic disease imposes a burden upon the country as a whole, the question arises, is it fair for large numbers of people to neglect proper care of their health and run the risk of making themselves a burden upon those who have kept well? Should not some more drastic means be used to limit the treatment of disease by those who merely pretend, or do not even pretend, to scientific knowledge?

Another phase of the problem is also of great importance. Individuals who follow cults force their favored method of treatment upon their minor children. Do they actually own their children, or are they their guardians, owing them the kind of care the courts would require any other legal guardians to provide? This question has often been answered in the courts, but too often it does not reach the courts.

Finally, there is the question of communicable disease. Because of their failure to appreciate the nature of communicable disease, large numbers of people are resisting, or even defying, the public health rules regarding isolation of the infected, and thereby are endangering the lives of others. Is this in accord with the principles of personal liberty in a democracy?

We are an independent people, and will not readily consent to having our liberty curtailed. However, we have already recognized the principle that a democratic people has a right to defend itself against those in the group that are its enemies. It would appear that both the leaders and the followers of cults may be in that category.

None of these matters have yet received the attention they warrant, and that they are bound to receive eventually.

What Is Being Done about Cults and Quackery.*

In every state the law prohibits practicing medicine without a license. When brought into court for breaking this law, the cultist may say "We prescribe no medicine, therefore we are not practising medicine."

They are not entitled to rest upon such a contention, for practicing medicine is treating sickness—by any means, not only by drugs. Never from the beginning of history has the practice of medicine been exclusively that of giving medicines. Always it has been the treatment of disease according to the standards of medical knowledge of the times, utilizing any and every recognized and proved method of treatment.

The word *medicine* has two separate meanings. In its broadest sense, it is the name of the *science* having to do with health and disease. Also, it is the name of a *substance* used to treat disease. The adjective medical has the same two meanings. Therefore medical treatment might mean treatment as given by medical science, or treatment by medicines.

When it is a question of proving that a person has been practicing medicine without a license, difficulties have often arisen over the interpretation of this word medical—the accused and his counsel insisting that it referred to drugs, and the prosecution not being able to establish the wider meaning. Usually the accused have not been convicted unless it could be shown that they did prescribe drugs or "used the knife."

It would appear that many states need to establish the definition of the terms medicine and medical before existing laws can be satisfactorily enforced.

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* *The Bureau of Investigation, of the American Medical Association, has for its primary object "the collection and dissemination of information on patent medicines, quacks, medical fads, and various other phases of pseudo-medicine." Its files contain the names of* 300,000 *charlatans, wth literature regarding them. This information is available to official boards, commercial organizations, etc., and to individuals. (Address,* 535 *North Dearborn Street, Chicago, Illinois.)*

No laws except those limiting the practice of medicine are specifically directed toward the checking of quackery and cults. All citizens are, of course, subject to the laws against fraud and crime. However, the cleverer and less scrupulous a person is, the more he has at stake financially, and the greater his financial resources, the greater the chance that he will be able to evade these laws. Although prosecutions occur frequently, convictions are much less frequent. Even the most outrageously fraudulent quacks seem to have little fear; and the more "respectable" cultists, none at all.

The one thing above all others that protects any non-scientific healer is the inalienable right of the individual to choose for himself any form of treatment he wishes, provided he does not place the public welfare in jeopardy. The question for the future will be, when is the public welfare jeopardized?

Chapter 17

NOSTRUMS AND SELF-MEDICATION

About $360,000,000 are spent every year by the American people for medicines sold "over the counter" without prescription. An investigation by the Home Economics Bureau of the Department of Agriculture in 1935 showed that even families of less than $500 income a year, nearly all spent some money for medicines, although not half saw a physician.

Is there any harm in this practice? Undoubtedly most people who buy medicine to dose themselves feel that they are saving money and saving health at the same time. But in many cases they are doing just the opposite—wasting both money and health.

So harmful may self-dosing be that acts of Congress have twice been passed in this country in the effort to protect citizens from the results of such folly.

The main danger is from nostrums, commonly known as patent medicines. However, the inappropriate use of official drugs is becoming of considerable importance. Each of these classes of medicines will be discussed and then the dangers involved in any sort of prescribing for one's self.

NOSTRUMS

A nostrum is a medicine *recommended* to the public by its preparer as a cure for human ills. Fifteen per cent of the total spent for health care (doctors' bills, hospital bills, medicines, etc.) in this country is spent for nostrums.

False Claims.

The odium attaching to the word nostrum arose from the fact that throughout history the nostrum vendor has been noted for making extravagant or even totally false claims about his product.

Sometimes the preparer of a nostrum is sincere in believing the claims he makes for it. This was the case, for example, with Bishop Berkeley, one of the greatest of English philosophers, who went astray on the subject of a preparation called Tar Water. He spent much of his time and literary ability in the latter part of his life

advocating this absurd treatment for all sorts of diseases. His belief in it was based on seeing several members of his family recover from fever after taking it, and not realizing that most fevers subside anyhow.

Far more often, unscrupulousness has marked the promoter of nostrums. He has characteristically preyed upon the fears and hopes of the ill, and taken their money in return for the health he promised but could not produce.

All along, the claims made for a nostrum have been as much as the gullible would believe. In times past many a nostrum was claimed to be a "cure-all"—good for any and every disease. But as popular enlightenment increased, such utterly fantastic claims were less often made, and most nostrums were claimed to cure only one disease, such as rheumatism, cancer, kidney trouble, etc. However, a new field opened; as standards for health increased, nostrum sellers found the public interested in curing not only the serious diseases but also the minor maladies such as indigestion, constipation, falling hair, bad breath, sore gums, and the like.

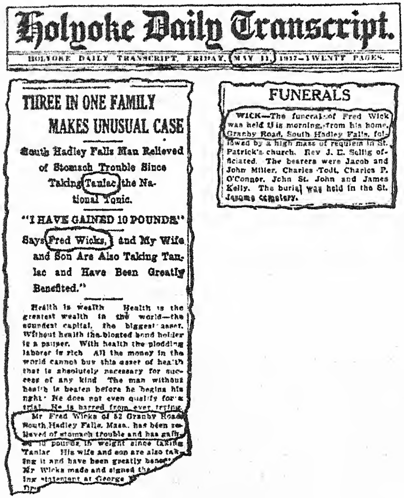
Today, the claims for nostrums are not so flamboyantly stated as of old. This is partly because of increasing scepticism on the part of the public, and partly because of the activities of governmental agencies in prosecuting those who perpetrate fraud. Today the claims for nostrums must sound scientific to the layman or he will not usually believe them; and they must be technically true, or their makers will be prosecuted. But in being technically true they may subtly suggest all manner of things. For example, they may use the word *relieve* instead of the word *cure*, but the whole tenor of the claim may suggest to the unwary that relieve and cure mean the same thing. The whole essence of the appeal of a nostrum is always and everywhere the falseness of the claims made for it, however cleverly the claim may be phrased. (See page 297.)

Reaching the Public.

Formerly the nostrum vendor was often an itinerant peddler, travelling from town to town, usually taking advantage of public gatherings such as fairs, at which he set up a stand and for a day or two did a profitable business. Many, however, have been permanently established in high and respected positions, even in the courts of nobles and kings.

There are still itinerant nostrum vendors, even in this country today. Some of them are of the peddler variety, but many of them lead luxurious lives, establishing themselves first in one fashionable

hotel and then in another, from which they make visits on patients with whom they have made appointments by mail. After selling their nostrums at fabulous prices and filling their pocketbooks, they move on to another field. Some of the "cancer cures" have been sold in this way.



Holyoke Daily Transcript.

HOLYOKE DAILY TRANSCRIPT, FRIDAY, MAY 11, 1917—TWENTY PAGES.

THREE IN ONE FAMILY MAKES UNUSUAL CASE

South Hadley Falls Man Relieved of Stomach Trouble Since Taking Tanlac, the National Tonic.

"I HAVE GAINED 10 POUNDS"

Says Fred Wicks, "and My Wife and Son Are Also Taking Tanlac and Have Been Greatly Benefited."

Health is wealth. Health is the greatest wealth in the world—the soundest capital, the biggest asset. Without health the bloated bond holder is a pauper. With health the plodding laborer is rich. All the money in the world cannot buy this asset of health that is absolutely necessary for success of any kind. The man without health is beaten before he begins his fight. He does not even qualify for a trial. He is barred from ever trying.

Mr. Fred Wicks of 52 Granby Road, South Hadley Falls, Mass., has been relieved of stomach trouble and has gained 10 pounds in weight since taking Tanlac. His wife and son are also taking it and have been greatly benefited. Mr. Wicks made and signed the following statement at George ... Dr...

FUNERALS

WICK—The funeral of Fred Wick was held this morning from his home, Granby Road, South Hadley Falls, followed by a high mass of requiem in St. Patrick's church. Rev. J. E. Sellig officiated. The bearers were Jacob and John Miller, Charles Todt, Charles P. O'Connor, John St. John and James Kelly. The burial was held in the St. Jerome cemetery.

Fig. 90.—Testimonial and funeral notice in same issue of a newspaper. (Used by permission of the American Medical Association.)

More often, the nostrum seller today does not see customers, but deals with them by mail. And the seller may be a company instead of an individual, carrying on its business through the usual commercial channels.

A nostrum is brought to the public attention largely through the lower grade newspapers and magazines, and over the air. Reputable publications and radio stations do not intend to advertise nostrums classed as harmful. Some of the nostrum vendors and quacks have gone to the huge expense of owning their own publications and radio broadcasting stations.

Creating a Demand.

The seller of nostrums does not rely upon an already existing demand for medicine, but seeks to create new demands. The foremost method is that of suggestive advertising, to make people symptom-conscious. If a suggestible person has his attention drawn often enough to a given symptom, he will first begin to wonder whether he has that symptom, then to be sure that he has it, and finally to be sure that he needs the particular remedy said to cure it.

If advertisements suggest that the symptom means some serious illness (e.g. that backache means kidney trouble), or that it will lead to serious conditions (e.g. "lost manhood") a person is all the more likely to buy the advertised remedy. In recent years it has been noted that a person also reacts very quickly to the suggestion that he has a symptom that makes him socially unacceptable.

Testimonials.

Printed advertising of nostrums relies greatly upon testimonials of those who have been "cured." Some of these no doubt are

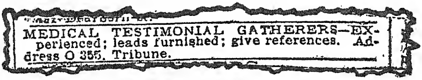


FIG. 91.—(Used by permission of the American Medical Association.)

voluntary statements from credulous individuals who happened to recover at the same time that they finished taking the medicine.

Or they may be from individuals temporarily relieved of symptoms but by no means cured. It is reported that Sir Robert Walpole, Prime Minister of England, consumed in his lifetime 180 pounds of soap and 1,200 gallons of lime water, prescribed by a quack, and that he sponsored this treatment of the ailment from which he eventually died.

Or they may even be from those who have died loyal to their false hopes (see Fig. 90).

Many testimonials are, however, not bona fide, but paid for in cash. To obtain them, persons are hired to scour the country for those willing to turn a dishonest penny in this way.

An Attorney-General of the United States stated to a Postmaster-General: "Speaking generally, it may be said that in all my experience in the office, never has a medical concern, no matter how fraudulent its methods or worthless its treatment, been unable

to produce an almost unlimited number of the so-called testimonial letters."

Price.

The amount that may be charged for a nostrum depends upon what the public will pay, not upon the cost of producing it. If the medicine is claimed to work wonders, and the public can be made to believe that, the cost may be exhorbitant. In any case, the cost must be enough to pay for the expensive advertising.

Oddly enough, the higher the price, the more efficacious the medicine is usually supposed to be. This fact was commented upon in 1380 by John Mirfield, who said, "When Physick's dearly bought it doth much healing bring, but when 'tis freely given, 'tis ne'er a useful thing."

Usually the makers of nostrums take some simple, inexpensive drug capable of relieving a symptom, mix it with something that tastes good, often with not a little alcohol, and sell it for anything up to hundreds of times its cost. For example, the popular indigestion remedies may contain only a cheap alkali, such as sodium bicarbonate, and flavoring. The same is true of all nostrums: if they did no harm to the health they still harm the pocketbook.

Composition.

Thousands of nostrums have been analyzed by governmental laboratories and by the Bureau of Investigation of the American Medical Association. Some have been found to be virtually inert—that is, incapable of exerting any effect whatever. Others contain drugs that of themselves would not do any great harm, yet indirectly may do so. Many contain stronger drugs, capable of seriously deranging health. Among these may be mentioned some of the reducing medicines containing thyroid extract, one of the most powerful drugs known to science. This and some eighteen other strong drugs must now be declared on the label of any medicine containing them. (See page 296.)

In general, the nostrum represents at best a worthless preparation for which a high price is paid, and at worst a dose of poison, for which health, or even life, may be paid. Almost never has the seller of a nostrum undertaken of his own accord to warn the buyer of any dangers. One exception was in the case of a nostrum popular for sleeplessness during the 18th century, which was sold with the warning that it be taken in moderate dosage, "lest ye party so treated wake not again till ye Resurrection."

The Term "Patent Medicine."

This term is usually a misnomer, since nostrums are as a rule trademarked and not patented. A patent requires that the ingredients be disclosed, and it lasts only seventeen years. A trademark permits secrecy as to ingredients and it lasts in perpetuity.

The person or company that trademarks a medicine acquires property rights in it, becoming its owner or proprietor. The trademarked medicine is therefore called a *proprietary medicine.*

Because such medicines are put up in packages (bottle or box) ready for sale to the consumer in the original container, they are also known as *package medicines.*

The layman should understand clearly that proprietary or package medicines are of two entirely different classes—those known as *nostrums* and those known as *ethical preparations.* The two classes are unlike in every respect except that they are both proprietary or package medicines. The manufacturer of a nostrum avails himself of his right to keep the formula secret; the manufacturer of an ethical product does not, but reveals it openly. The nostrum is advertised and recommended to the public; the ethical product is not, but only to physicians.

Control of Nostrums.

Governmental agencies can and do deal with nostrums that are actually poisonous, or that would be seriously harmful to the average person if taken without medical supervision.

In 1906 the danger of nostrums was recognized so clearly that Federal legislation (the Pure Food and Drug Act) was passed to combat it. At that time, patent medicines were among the most serious chemical hazards to life. It was estimated that 15,000 children died annually as a result of "soothing syrups" containing narcotic drugs.

The Act mentioned was directed especially toward the narcotic drugs. It provided that the presence and amount of any of eleven narcotic drugs in a medicine had to be declared on the label, and if the quantity was above a specified minimum, the medicine could not be sold without a physician's prescription. This act did much to control acute poisoning by narcotics, but it was not inclusive enough.

Therefore, after working over a new Act for five years and one day, Congress passed the Food, Drug and Cosmetic Act of 1938. It is designed to prevent injury to health.

Regarding drugs, it utilizes two methods. First, it applies the method of *testing*. All new drugs must be tested and approved before being put on sale in interstate traffic. The first drug to be so tested and passed by the Food and Drug Administration, with the approval of the Council on Pharmacy of the American Medical Association, was sulfapyridine, the drug which since its approval in March 1939 has been successfully utilized in the treatment of pneumonia.

The second method is that of *labeling*. It prohibits traffic in drugs and devices dangerous to health under the conditions of use prescribed on the labeling. This means that the manufacturers must label drugs in such a way as to indicate their dangers. The rules apply to all medicines except physicians' prescriptions.

The old list of narcotic drugs has been increased to include certain powerful hypnotics. Medicine containing them must bear on the label the name and amount of the drug or any of its derivatives, and also the words "WARNING—MAY BE HABIT-FORMING"

The following is the list of narcotics and hypnotics that must be stated on labels:

alpha-eucaine	codeine
barbituric acid	heroin
beta-eucaine	marihuana
bromal	morphine
cannabis	opium
carbromal	paraldehyde
chloral	peyote
coca	sulphonmethane
cocaine	

or any chemical derivative of such substances.

Also, it requires that labels must state every active ingredient in a medicine, and of the following eighteen drugs or their derivatives in any amount:

bromides	arsenic
ethers	digitalis
chloroform	digitalis glucosides
acetanilid	mercury
acetphenacetin	ouabain
amidopyrine	strophanthin
antipyrine	strychnine
atropine	thyroid
hyoscine	hyoscyamine

or any derivitative thereof.

With the names of the active ingredients, must also be given warnings as to possible harmful effects. For example, castor oil bears the following warning: "*Not to be used when abdominal pain (stomach ache, cramps, colic), nausea, vomiting (stomach sickness) or other symptoms of appendicitis are present. Frequent or continued use of this preparation may result in dependence on laxatives. Do not use during pregnancy except on competent advice.*"

Since some medicines change with age, sometimes becoming more poisonous, the new law requires that warnings of deterioration be used when necessary.

Whether this Act assumes too much intelligence on the part of the public remains to be seen. Many authorities believe that the public will read labels and be warned by them. The fact remains, however, that potentially poisonous medicines are still accessible to the public without physicians' prescriptions, and that overdosage with poisonous effect is still likely to occur.

Regarding *fraudulent advertising*, the conditions have changed somewhat since 1938. Before that time, *damage to a competitor* was the only ground for action in limiting misleading advertising of food, drugs, cosmetics and health devices. The new Act of 1938, amending the Federal Trade Commission Act, makes the *harmfulness to the consumer* the important factor. It is now unlawful to disseminate any false advertisement, i.e. one that is misleading in any material respect; and if the commodity advertised "may be injurious to health when used under conditions mentioned in the advertisement," the penalty is a fine of not more than $5,000 or imprisonment for not more than 6 months, or both. It remains to be seen how deterrent an effect these penalties will have.

In addition, as has always been the case, any product offered for sale to the public is subject to the laws against using the mails to defraud.

It appears that in a democratic country no governmental regulations can ever fully control the sale of nostrums. As long as the public demands them, the supply will be forthcoming. It becomes, then, a personal matter, whether to take nostrums or to leave them alone.

LEGITIMATE DRUGS

Official Drugs.

It is essential for good medical treatment that drugs correspond to definite standards of purity and uniformity in strength. A physician who prescribes a drug must know its potency in order to gauge

the dose. Therefore standards are regulated by law. The book in which these standards are published is called the *Pharmacopeia*. The first edition was published in 1820, and revised editions are issued every ten years. Preparations listed and described in it are called *official drugs*.

In 1906 an international conference at Brussels began the work of establishing international standards of uniformity for drugs. Agreements were reached regarding many of the more potent drugs, and in our Pharmacopeia these bear the letters *P.I.* (*Protocol International*).

Another book of legal standards is the *National Formulary*, issued by the American Pharmaceutical Association. It contains the less important formulas.

To provide official drugs that meet legal standards is the work of the wholesale pharmaceutical manufacturers. Many of the larger companies conduct laboratories for the testing of drugs. Their chief business is that of making single drugs, sold to retail pharmacists to be used in filling physicians' prescriptions. The medical profession and the public owes a great debt to both wholesale and retail pharmacists for their cooperation in this important phase of treatment of disease.

New and Non-official Remedies.

A third standard list of medicines, "*New and Non-official Remedies*," is issued by the American Medical Association. It includes proprietary medicines of the ethical sort previously mentioned, after they have been tested by the medical profession, and have been examined and approved by the Association's Council on Pharmacy and Therapy.

Physicians as a rule do not prescribe any medicines that are not listed either as U.S.P. or N.F. or N.N.R. These three lists contain in all about 1,700 drugs of proved value.

Many proprietary medicines are manufacturers' particular brands of official drugs, differing from each other and from the official drug only in matters of refinement, form, and the like. Others are compounds—virtually prescriptions put up wholesale. Many proprietary medicines are among our most valuable drugs.

Sometimes a proprietary medicine is the product of extensive research by a pharmaceutical manufacturer, in order to make available new forms of treatment. After his research shows it to be successful, he presents it to physicians for trial. If they, too, find it

successful, the drug will be submitted to the Council mentioned above, and when approved will be placed upon the N.N.R. list.

Many new remedies are the discoveries of physicians and other scientists working in laboratories and clinics. Usually new drugs are not discovered by chance, but are the product of long years of research, based upon valid theories that a preparation could be found that would have a given effect. In acting upon such theories, many experiments may be needed. For example, Ehrlich made 606 different preparations of arsenic before he discovered salvarsan as a cure for syphilis—for which reason salvasan is sometimes known as "606."

The Prescription.

The profession of pharmacy is nearly, if not quite, as old as that of medicine. There was a time in the history of this country when physicians dispensed their own medicines, and they do so to some extent here and in other countries today. Ordinarily they now write prescriptions and entrust them to the pharmacist, or druggist, to fill.

To practice pharmacy, the individual must be a graduate of a college of pharmacy, and must be examined and licensed by the state. Documents indicating these facts will usually be displayed on his premises.

Prescriptions are either for official drugs, singly or in combination, or for package medicines. The former call for the work of the practicing pharmacist, the latter represent the work of the pharmacists connected with the wholesale manufacturing companies. In either case, there is absolute certainty that professional skill has been used in the making of the preparation the physician orders under the sign ℞.

Prescriptions are written in Latin when the scientific name of the drug is Latin. Today, many of the drugs are designated by their chemical names, or by the trade name given them by their manufacturers.

SELF-MEDICATION

Many a person who would never consider taking a nostrum doses himself freely with what he looks upon as "good" medicine—by which he means standard drugs known to have beneficial effects—but he is often running into trouble when he does so.

Medicines: Good, Bad, and Indifferent.

From all points of view, that which distinguishes a good medicine from a bad medicine is its suitability for the person in

question. The following questions must invariably be asked regarding a medicine one proposes to take.

1. *Will the medicine produce the expected beneficial effects?* The medicines most commonly purchased without prescription today are reported to be the cathartic and laxative drugs, the pain relieving drugs, cough medicines, and the sleep-producing or "lullaby" drugs—with the vitamin preparations and the medicines classed as tonics near the top of the list. Most medicines sold for these purposes answer the first requirement, in that they are capable of producing the effect they are expected to produce (i.e. they are potent).

2. *Does the individual need to have such beneficial effects as the medicine will produce?* Many drugs are taken when it is not suitable that their effects be produced. This is particularly true of the pain-relieving drugs. Pain is evidence that something is wrong, and to deaden pain often means hiding the evidence of a progressive ailment. For example, an analgesic (pain-relieving) medicine might quiet an earache, while the mastoid cells were becoming infected; or a headache, when the eyes needed rest. Similarly, a cough medicine might check a cough by drying the secretions when they needed to be made more fluid so as to be easily expelled.

3. *Is the medicine certain not to produce harmful effects out-weighing its good effects?* The possibility of harm from a given drug may depend upon the condition of the individual. For some individuals in a given condition, a drug might be virtually poisonous. For example, tonics containing strychnine might be seriously overstimulating.

Or the possibilities of harm may depend upon the way a drug is administered. Many drugs that are harmless if administered by a physician with care as to dosage, and with tests concurrently done to check upon its effects, if less carefully used are potentially seriously harmful. This is the case, for example, with that remarkable drug sulfanilamide. It has nearly every fault that a drug could have—and one virtue, its action against certain bacteria. An experienced physician can manage to use this drug so as to make it exert its one good effect and none of its bad effects. The layman would not know how to keep it from having its destructive action upon blood cells (up to the point of causing death) nor its effect on the nervous system that makes driving a car as hazardous as does intoxication

by alcohol. Any drug that affects the body at all may affect it in the wrong way. Few drugs are never harmful.

4. *Will the medicine fully meet the need?* Even if it could be certain that a drug was potent, was needed, and would not be harmful, there remains the question whether it is all that one needs. For example, most vitamin preparations are potent, not harmful (except possibly for an excess of vitamin D), and may be assumed to be needed in the case of those who cannot obtain or assimilate an adequate diet. Much the same may be said of tonics whose active ingredient is iron. But if a person needs "bracing up" he may need something besides vitamins and iron. He may, for example, owe his tired feelings to tuberculosis or overwork or cancer or some other condition that needs to be discovered and corrected. In other words, although a "good" medicine may help him, it may not help him enough.

The matter of delay in getting the right treatment is one of the main objections to self-medication. While "taking something" for an ailment, valuable time may be lost.

To summarize: medicines usually cannot be classified as good, bad or indifferent, except with reference to the condition of the individual who is to take them.

How to Take Advantage of Medicines.

To find medicines that would heal mankind's ills, sooth his pains, and calm his spirit has been the effort of the medical profession for countless ages. In the present generation, the physician has available hundreds of potent drugs, which he spends years studying how to use skilfully so as to produce precisely the right effect and no other. All the vast potential benefit of medicines is available to the layman simply through calling upon his physician's knowledge.

Ideally, the wise person will do the following. He will obtain medical advice whenever he thinks he needs medicine. He will not demand medicine if the physician thinks he does not need it. If he does receive a prescription he will take it strictly according to directions. He will not have it refilled unless the doctor has told him he could. And he will not, of course, pass the prescription to someone else who seems to have the same symptoms. Finally, he will discard any that is left over, and not keep it to take at another time when he seems to have the same symptoms, unless he has been told to do so. In other words, he will realize that a prescription is for a given individual in a given condition.

Is it necessary to see a physician for every little ache or pain? Has not an intelligent person a right to take simple medicines on his own account? Ideally, the answer to both questions is, No—with one exception.

The only time when an individual is at all justified in using his own discretion about taking medicines is when he has obtained from his physician the names of medicines that he might safely use in given conditions. The question then will be whether such conditions are present or not.

To answer that question he will have to make a layman's diagnosis, and it may not be correct. It is, for example, difficult for a layman to be certain whether uncomfortable feelings in the abdomen are due to constipation or to appendicitis, and whether a chest cold is merely that, or beginning pneumonia. Furthermore, even if his diagnosis were correct, his judgment regarding the need of medicine might be faulty.

In regard to medicines, the individual who utilizes the judgment of medical science is the one who stands to profit most from them.

Chapter 18

PREVENTIVE MEDICINE AND PUBLIC HEALTH

It has always been man's hope that somehow he could keep disease from coming upon him. The very first accounts of man's life tell of his wearing charms and amulets and carrying "lucky stones" to ward off the demons that brought disease and regulating his activities with respect to good omens and favorable constellations; and of whole tribes uniting in group dances, incantations and ceremonies to drive away or to appease the evil spirits threatening them all.

Throughout history, both personal efforts and group or public efforts in behalf of health have been made. Their success, however, awaited the modern period when science was able to point the way to the real dangers to health and the methods of combatting them. The concept of prevention is as old as the mind of man; but achievements in prevention are with few exceptions the triumphs of the 20th century.

Today there exists a well rounded program of preventive medicine in all civilized lands. The term preventive medicine includes any and every sort of work to prevent disease. It has two major aspects: (a) work directed specifically toward the causes of disease; and (b) work directed toward the upbuilding of health. The latter sort of work has recently been called constructive medicine.

As of old, preventive medical work today is both a personal matter and a group matter. Its aims are realizable through the efforts of individuals, applying the wisdom of medical science in their own lives, and of groups uniting to provide health facilities for themselves or others. The former may be called *personal* preventive medicine; and the latter, *public.*

This division is a somewhat artificial one except to indicate where action starts. As used here, the terms personal and public are used to distinguish between work done by an individual in a private capacity (with his own health as the immediate objective) and work done by organized groups (with group health as the immediate objective). However, when considered from the point of view of ultimate benefits, it must be clear that in either case the

benefits accrue to both the individual and society as a whole, for the interests of the individual and society are so closely intertwined that what helps each helps all, and what helps all helps each.

A. PERSONAL PREVENTIVE MEDICINE

The individual acting in a private capacity and on his own initiative can protect his health by three major methods: first, by the study and practice of hygiene; second, by obtaining medical advice and care while he is still well; and third, by taking part in group undertakings in behalf of public health.

The Study and Practice of Hygiene.

Even while still believing firmly in magic, man began to note that the way he lived his daily life made a difference in his health. The first shrewd observations concerned cleanliness. In fact, cleanliness was the keynote in personal prevention for many centuries. To this day, it is hard for many people to realize that the terms cleanliness and hygiene are not synonymous.

European civilization derived its standards of personal cleanliness from the ancient Hebrews, but it has been found that similar standards prevailed among other early peoples. The code of the Hindus, for example, was as specific as the Hebrews'; it gave rules for keeping the hands clean, and ordered that the right hand be washed ten times and the left seven.

The implication behind the concept of cleanliness was that disease came from filth. But even in earliest times it was recognized that disease could arise from disordered function of the body itself. Upon this principle the Hebrews' code commanded one day of rest in seven. It remained, however, for the Greeks to extend this principle to all aspects of life. The cult of physical fitness, as manifested in Greece, laid the foundation of what we now call constructive medicine. The ideal was perfect health, perfect development of the human body, in strength and in beauty.

One of the methods used to reach this standard was physical training, for which the Greeks established gymnasia. This concept, like that of cleanliness, has been attached to hygiene ever since, and today in many colleges hygiene and physical education are joined in one department. It is an interesting fact that the first college gymnasium in this country (Amherst, 1859) was started as a result of a college president's study of the classics and his desire to revive the Greek ideal.

Hippocrates, the first great physician, showed full appreciation of matters of personal living as factors in determining health. In fact he classified disease as due to external and internal causes, and stressed such points as the danger of obesity—an ailment peculiarly personal both in prevention and cure.

It is hard to understand why such an ideal of physical perfection as was set up by the Greeks should ever have declined. But the fact remains that in Europe throughout the Dark Ages man existed in sordid unconcern for any aspect of personal hygiene. Michelet speaks of the "thousand years without a bath."

Eventually, through the Arabs and the medical school at Salerno, Italy, Greek medicine returned to Europe, and the concept of health was born again. It has been with us ever since, becoming clearer with the progress of the centuries.

Today, conditions of living are more complicated than ever before, but the knowledge of living conditions and of the human body has increased. We are justified today in pursuing the shining goal that enticed the Greeks of old—the glory of health, the glory of life itself in all its beauty and power.

Preclinical Medical Service.

The personal application of science in everyday living is unquestionably the most fundamental aspect of preventive medicine today—the method whereby the next great advances can be expected. To live at his best, it is necessary at times for an individual to have personal contact with medical science, and personal advice.

The term preclinical is applied to medical work done by physicians for the well, to keep them well and to add to their health. As has been mentioned, in two of the fields of medicine (obstetrics and pediatrics) the public today makes wide use of this service. In the field of general medicine, preclinical care is offered to students in many colleges, to young men in the Army, Navy and Merchant Marine, to employees in certain commercial and industrial concerns, and to persons in many other groups. Some individuals not having this service provided for them seek it of their private physicians, but most people have not yet learned to look upon it as an essential part of the care of their health.

The value of preclinical service rests largely upon the *health examination*. For years it has been advocated that every individual have such an examination annually. It may be of use to him in three ways. First, it may disclose *unsuspected disease* needing treatment. Second, it may disclose *tendencies toward disease* suggesting changes in

the way of living. To discover such tendencies requires careful medical assessment of the family and racial background; the biological and constitutional type; the intellectual equipment; the prevailing environmental and social factors, and the ability to adapt to them; the use of energy, including available supply and customary kind and amount of output in occupation and recreation; etc., etc. Third, the examination may disclose that *health* is present, and the good habits necessary to maintain it, and may thereby have value as reassurance.

That pre-clinical medicine began before the 17th century is indicated by the words of Sir Francis Bacon in his "Advancement of Learning," a review of the state of knowledge in his own time. Shortly after 1600 he wrote:

"This is a new part of medicine and deficient, though the most noble of all; for if it may be supplied, medicine will not then be wholly versed in sordid cures, nor physicians be honored only for necessity, but as dispensers of the greatest earthly happiness that could well be conferred on mortals."

Incidentally, Sir Francis Bacon seems not to have profitted to the full by his appreciation of personal preventive measures, for he died of a cold acquired while stuffing a chicken with snow to find out the effects of refrigeration as a means of preserving food.

As time went on, personal preventive medicine does seem to have established itself in the scheme of things, for in 1683 in the foreword of a book by Roger Bacon, the great mathematician and physician of the Middle Ages, the translator wrote these words:

"And now, Sir, how do you? You find no pain, and think all is well. A physician seems as useless as a captain in time of peace. Consider well, that fortification, a main point in the art of war, is most properly exercised in peace and that it is too late to build the walls when the gate should be shut against the enemy. And I count it a piece of skill in a physician far surpassing the most admirable cures, to preserve a man from disease."

At the beginning of this century Dr. George M. Gould, oculist and editor of the medical dictionary that bears his name, sounded the note of modern preclinical medicine when he said "All good physicians labor to stop disease before it arrives. . . . The greatest therapist is he who cures before disease exists."

Cooperation in Public Health Work.

A third method of personal prevention is that of joining wholeheartedly in group undertakings in behalf of health. Regardless of

the social responsibility involved, there is personal benefit to be obtained from living in a well-ordered, healthy community. One protects one's self indirectly when taking steps to improve group health. It may be very indirectly yet very certainly—through the ramifications of social and economic relationships.

B. PUBLIC HEALTH

A. Beginnings of Public Health

Ancient Times.

Like personal hygiene, public hygiene began with *cleanliness*. The Hebrew sanitary code stressed cleanliness of all sorts—of environment, food and water, as well as of person. The principles of *sanitation* that eventually prevailed over all Europe began with this discerning concept of the Hebrews.

A second concept of great importance originated among the ancient Hebrews—that of *contagion*. And upon that assumption, they instituted the second method of prevention—that of *isolation* of those ill with the contagious diseases. From Biblical accounts, that method was rigorously applied in the case of lepers. It was decreed "All the days wherein the plague is in him he shall be defiled; he is unclean; he shall dwell alone; without the camp shall his habitation be."

Even the possibility of transfer of disease by clothing was recognized. If the priest found the garment of the leper "unclean" the rule was, "he shall therefore burn that garment, whether warp or woof, in woolen or in linen, or anything of skin, wherein the plague is; for it is a fretting leprosy; it shall be burnt in the fire." From this source we derived the concept of inanimate objects as *vehicles* of disease, and of *disinfection* of such objects.

The Hebrews may be considered as the "fathers of public health." The principles they so early established have been supplemented, but not supplanted.

The next great advance in sanitation was made by the Romans They were the originators of *sanitary engineering*. Recognizing that the water supply in thickly inhabited districts was certain to be polluted, they conceived the idea of piping water into cities from clean sources at a distance. They constructed a wonderful system of aqueducts, some of them twenty-five miles long, and so soundly built that three of them, repaired and restored, are in use today. The first, the Appian aqueduct, dates from 312 B.C.. The Romans also built sewers, such as the Cloaca Maxima, which is still in

operation, but these were only for underground drainage and for storm water, not for domestic waste.

Another triumph of Roman engineering skill was their system of public baths. Every town and village had its bath, built in two sections, one for men and one for women. It is said that the city of Rome had 800 such baths. The most magnificent were the eleven Thermae, so called because they furnished both hot and cold water. Of these, the Pantheon of Agrippa still stands.

The Dark Ages.

After the fall of Rome, 476 A.D., there followed many centuries during which the whole population of Europe was under the twin clouds of war and disease. Plague and pestilence stalked the land, killing millions. It is thought that the average length of life could hardly have been more than eight years.

During this epoch the time-honored methods of sanitation and isolation were used, but without much effect, since the knowledge of the bacterial causes of these diseases was still lacking. Sanitation was directed only toward visible filth; persons and things that looked clean were supposed to be clean. Isolation was applied more strictly than ever, but not strictly enough. For example, the leper was allowed to go to the village well and dip his cup into it for water if he went there when no one else was there. Most of the indirect modes of transfer of disease were not suspected.

Renaissance.

With the awakening of European civilization at the time of the Italian Renaissance, still more vigorous attacks upon communicable disease were made, for frightful epidemics continued to afflict all countries. It is estimated that the "Black Death" destroyed half the population of Europe. During this period, *hospitals for isolation* were built in many cities. Also, *quarantine* was used for the first time. It originated in Italy; the word is from the Italian (*quarante*, forty). Ships having cases of pestilence aboard were detained in harbor for forty days before anyone was allowed to disembark.

At this time cities began to pass *municipal laws* for the regulation of public health. One of the first to do so was Siena, in the 13th century. This came about through a professor of medicine at the University of Siena, who afterward became Pope John XXI. The laws concerned community sanitation, isolation and disinfection, and the newly developed system of intercity quarantine, which was practiced during epidemics.

London, too, began its municipal health work early. During the 13th and 14th centuries laws were made requiring each householder to keep the street in front of his own house clean, and forbidding the throwing of filth and the wandering of pigs in streets.

In 1357, King Edward III enjoined all Mayors and Sherriffs to see to it that no filth was thrown into the Thames River. He said that he had "perceived the fumes and abominable stenches arising therefrom; from the corruption of which, if tolerated, great peril, as well to the persons dwelling within the said city as to nobles and others passing along the river, will, it is feared, arise."

A little later, Henry VIII appointed commissioners of sewers and issued edicts regarding municipal sanitation for English cities.

By the end of the 14th century, twelve diseases besides *leprosy* and *plague* were recognized as communicable: *smallpox*, which caused an enormous death rate among infants and children; *measles*, then a highly fatal disease; *influenza*, then known as "sweating sickness"; *typhus*, which included the disease we now know as typhoid; *erysipelas*, then called "St. Anthony's fire," a serious epidemic disease; *tuberculosis* of the lungs; *diphtheria; anthrax;* infection of the eyes in the newborn of the type now known to be due to *gonorrhea; trachoma*, another eye infection; *scabies;* and *impetigo*. Shortly *syphilis* appeared in Europe and was added to the list. Cholera and yellow fever did not appear until later.

Historically, the modern period is usually thought to have begun at about the time the printing press was invented and America was discovered, but it did not begin until much later in public health. During the 16th and 17th centuries there was little advance, because the new discoveries in medicine during that period shed little light on the epidemic diseases which continued to be the overwhelming cause of sickness and death. Such discoveries as were made served to confirm the age-old theory that disease was bred in filth. When the microscopists of the 17th century found "worms" or "animalcules" in decaying matter, in the blood of those with plague, and in the excretions of the well, these findings intensified an already keen interest in sanitation, and a belief in the efficacy of the methods then in use.

Premodern Period.

The modern period in public health began with the discovery of bacteria in 1876, but the century preceding that time was marked by such important changes that it deserves to be distinguished from

previous times and to be called the premodern period. Four great developments occurred, which will be mentioned in the next four sections.

(*A*) *Boards of Health.*—From about the time the United States became a nation, interest in public health in all civilized lands became greatly intensified; the feeling grew that the epidemic diseases could be controlled by organized action. Therefore in most of the countries of Europe and in this country official governmental boards began to be formed, charged with the duty of maintaining healthful conditions in their jurisdiction. Twelve states and 135 cities had established boards of health prior to 1876.

A new term arose during this period; sanitary work was dignified by the name of "nuisance abatement." A nuisance was anything that looked dirty or smelled bad. All nuisances were supposed to be a menace to health. In those days garbage disposal really was under the care of the board of health, as many people still believe it is. However, the main interest, as in all former times, was in the *water supply* and the *disposal of sewage.*

Also, official work to prevent contagion was greatly increased. Nearly every sizable town had its "pest house" for isolation. Quarantine, too was more widely used. In this country the first sanitary law of which we have record is a quarantine law passed by the Governor and Company of Massachusetts Bay, to keep out yellow fever then raging in the West Indies. Maritime quarantine became a matter of Federal concern almost as soon as the states united.

(*B*) *Sanitary Engineering.*—With increasing populations and increasing difficulties in maintaining sanitary conditions in cities, engineering science was called into the service of public health. The old Roman methods of sanitary engineering were revived, and water was again piped from presumably safe sources into cities. In this country, by 1800, sixteen cities had such municipal water works, and by 1850, eighty-three.

Obviously, the communicable diseases that were due to contamination of water by excreta were bound to decrease in proportion to the purity of the water supply. Sanitary engineering made large contributions to human welfare even before the specific organisms causing water-borne diseases had been discovered.

As for public sewage disposal, progress came more slowly. Although sewers were built, they were, as in Rome, for carrying away storm water and draining the ground, but not for domestic waste. It was not until 1815 in London that sewers were used to carry

excreta. When visitors to Paris in the 19th century were taken on trips through the sewers, it was not sewers as we now know them, but merely drains for stormflow. In this country, sewers were first used in Boston, in 1833, for the purpose now known to be the most important, and in other cities much later. (Even in 1922, one of our largest cities still had not completed its sewage system, and 20,000 houses were still unconnected with it.)

(*C*) *Vital Statistics.*—The utility of any public health measure can be gauged only by the use of vital statistics (statistics about lives) to compare conditions before it was used and after. Before the middle of the 19th century such comparisons could not be made with any degree of accuracy, for vital statistics did not become a science until about that time.

Some of the early peoples had enumerated their population by census; the Hebrews did so, and also the Romans. Births had also been counted, but not regularly except in Rome at the time of Galen. Data regarding deaths became of interest in the Middle Ages. The first law requiring the reporting of deaths appears to have been passed in London in 1592, following the publication in that year of the first book on vital statistics, written by John Graunt.

Later, Halley, the astronomer, turned his attention to this subject, and in 1693 was engaged by the city of Breslau, Germany, to compile vital statistics. The object, he wrote, was "to show the proportion of men able to bear arms in any multitude, to estimate mortality rates, and to ascertain the price of annuities upon lives." He anticipated the military, public health and insurance value of vital statistics.

Early in the 19th century interest in vital statistics expanded. Four cities in this country (New York, Philadelphia, Boston and New Orleans) have mortality records dating back to 1815. But even by 1876 only two states claimed to have accurate records of births and deaths.

In England in the 1840's the work of William Farr, M.D. established vital statistics as a science and as a function of government. Since then, public health work everywhere has increasingly made use of statistical evidence to find out what conditions prevail and to check upon the results of work done.

The first reliable vital statistics showed that mortality rates were appallingly high. In cities having records dating back to that time, it appears that expectation of life then was scarcely more than half what it is now. The highest causes of death, moreover, were still the epidemic diseases—typhus, typhoid, cholera, yellow fever,

diphtheria, etc.—the very diseases against which sanitation was particularly directed.

(*D*) *Discovery of Immunity.*—The outstanding development of the premodern period—and one of the greatest discoveries in history—was the discovery of an entirely new method of attack upon epidemic disease.

Until 1798, there was no certain and specific and harmless way to protect individuals against any of the prevalent plagues. Against only one disease had anything of the sort been even attempted. In England in the middle of the eighteenth century Lady Mary Montague had returned from the east with the story that smallpox was being prevented there by inoculating the well with material from the sores of a person ill with the disease. This method was tried throughout Europe and America, and it was learned that while some people were successfully immunized, others took the disease as a result of the inoculation and died of it. The desperate state of mind of the populace in those days is shown by the fact that large numbers of people grasped eagerly for the doubtful chance that inoculation gave them instead of waiting for the attack of the disease that was sure to come to them sooner or later.

In 1798, the whole situation in regard to smallpox changed. Edward Jenner, a celebrated English physician, who had also contributed much to the knowledge of heart disease, announced that he had discovered an entirely safe and sure method of preventing smallpox. He had observed that milk maids who had had an attack of a mild disease of cows (cowpox, or vaccinia) escaped having smallpox. He conceived the idea of inoculating people with vaccinia, rather than with smallpox itself, knowing that vaccinia would not endanger them and might protect them just as the dairy maids had been naturally protected through having their hands infected from cows. The method worked; vaccination gave only the mildest of local reactions, and protected against smallpox as completely as an attack of the disease itself.

Physicians in that year for the first time in history had at their disposal a preventive measure that they could say with certainty would actually prevent one of the pestilences.

This epoch-making event had two results. First, it greatly reduced the amount of smallpox. Although most people could not seem to understand that vaccination was entirely different from the old time inoculation with smallpox itself, many people gladly availed themselves of its certain protection. Second, it kindled an extraordinary interest in the possibility of finding other similar

measures for personal prevention of disease. Work went on in many laboratories, but it was nearly 80 years before that hope was realized.

The Modern Period.

A new era began in medicine with Pasteur's proof, in 1876, that the anthrax bacillus was the cause of anthrax. Upon this foundation there developed the science of *bacteriology* and its companion science, *immunology*. These sciences provided both preventive and curative methods, and offered the solution of some of the major problems of public health. Furthermore, they gave rise to a third science,

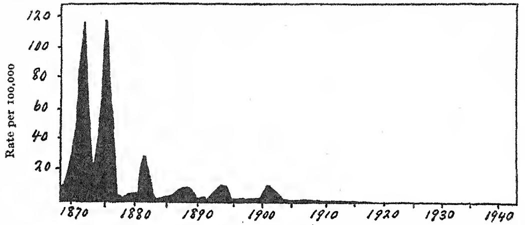


FIG. 92.—Typhoid fever was a dreaded disease until public water supplies were properly purified. The greatest reduction in typhoid has come since inoculation made immunity possible.

epidemiology, the study of the life history of communicable diseases in communities.

With these three sciences to aid them, workers in public health reviewed all the work they had been doing in the past, revised some of their methods in the light of the new knowledge (for example, improved the systems of water purification by checking methods according to bacteriological tests) and added new methods (for example, the pasteurization of milk, which previously had scarcely been suspected of being unsafe in its raw state).

At each new advance in these sciences, health agencies siezed upon the opportunities they afforded for large-scale preventive work, with the result that one by one most of the pestilences of old have either been banished or brought under control.

As soon as the problems of communicable disease began to be solved, public interest in the prevention of other diseases increased, until now there is hardly a disease which is not included in the program of some public health agency.

B. Public Health Today

Organization and Personnel.

Public health work is that which is carried on by an organization. The organization may be an *official* governmental one, or a *non-official* private one. All towns and cities, many counties, all states, and the Federal government have boards, divisions, departments, or commissions engaged in public health work. Also, many private organizations (called private because they are financed privately rather than by taxation) carry on health work that for one reason or another does not appear to fall within the scope of official agencies. Among these may be mentioned the American Red Cross, the American Medical Association, the American Public Health Association, the National Tuberculosis Association, and a number of others, the names of which are given in the Appendix.

In addition to the physicians engaged in public health work, there are members of numerous other professions, among which are doctors of public health, sanitary engineers and others trained in sanitation, bacteriologists, chemists, statisticians, nurses, epidemiologists, etc. A total of twenty odd professions are represented today in the public attack upon disease.

Methods of Public Health Work.

Most of the work done for the public health utilizes the following methods, under an administrator or director:

1. Vital statistics.
2. Sanitary engineering.
3. Laws and Regulations, preventive and constructive.
4. Finding and diagnosing disease (by laboratory, clinical, and field work, with reference to communicable diseases and certain others).
5. Treating disease (by furnishing biological products for communicable diseases; conducting hospitals and clinics; etc.).
6. Research regarding causes, prevention and treatment of disease (in laboratories, hospitals, schools, industries, etc.).
7. Education of the public regarding prevention and cure (by public health nurses, publicity, etc.).

Major Fields of Interest

With the methods just mentioned, work is carried on in various fields, which may be classified according to the disease problem involved, the group to be protected, or the sanitary objective.

a. The Disease Problem.—All diseases may be classed as communicable or non-communicable. Official agencies group the communicable diseases as one field—that of epidemiology. In some cases, special divisions exist for one or more particular communicable disease—e.g. tuberculosis and venereal disease.

As for the non-communicable diseases, official agencies sometimes, but not always, devote special attention to one or more of them (e.g. mental disease, cancer, narcotic addiction, food deficiency diseases, etc.). Often these diseases are dealt with more particularly in connection with the special groups of people in which they appear (e.g. chemical poisonings in connection with industrial workers, etc.). Non-official agencies exist for work with practically all of the major non-communicable diseases (e.g. blindness, crippling, heart disease, cancer, etc.).

b. The Groups to Be Protected.—These are classifiable according to age or according to situation. Thus, work is done for infants and expectant mothers, for children (pre-school and school), for industrial workers (with reference to all types of occupational disease), for the indigent, etc.

c. Sanitary Objectives.—There are: pure water, pure milk, pure food, pure air, good housing, clean streets, and a host of specific matters that arise in connection with specific problems. As a rule today the large work in municipal sanitation (water supply and sewage disposal) is done by special municipal departments of engineering, their work being checked bacteriologically by departments of health.

State and City Organization.

The major portion of the public health work in this country is done by states and cities. Through the Constitution, the control and regulation of matters of public health were left in the hands of the individual states. In turn, the states delegated much of their power to local communities. For example, the first state act in behalf of public health was that of Massachusetts, in 1797, and it provided for a system of local health administration. Shortly, a Board of Health was established in Boston, with Paul Revere as its president.

As an example of the work of a state department of health in modern times, a chart is shown of the work in Massachusetts. (Fig. 93.) Similar work is done in most states.

The work of a large city, New York, is shown in Figs. 94 and 95. Few cities have problems of the same scope, yet many of them

have comparable organization. However, good municipal health work is by no means universal. It is reported that three fourths of 211 cities having over 50,000 population do not have trained men directing their sanitation programs. In the smaller cities and towns there are nearly everywhere great possibilities of improvement.

ORGANIZATION OF MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

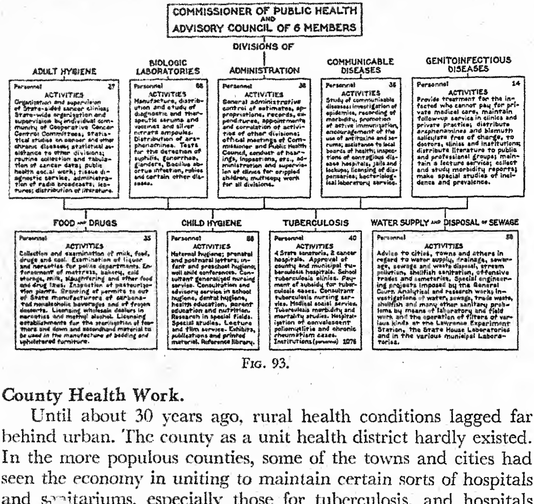


FIG. 93.

County Health Work.

Until about 30 years ago, rural health conditions lagged far behind urban. The county as a unit health district hardly existed. In the more populous counties, some of the towns and cities had seen the economy in uniting to maintain certain sorts of hospitals and sanitariums, especially those for tuberculosis, and hospitals for the poor, on the theory that one good hospital for the group was preferable to several inferior ones.

In the counties, usually no sort of public health work at all was done, as the separate communities could not afford health officers. Gradually they have found that they can pool their funds, and between them carry on health work comparable to that of cities.

The first county to do this was Jefferson County in Kentucky in 1908. Three years later, two more counties in widely separated parts of the country did the same—Yakima County, Washington, and Guilford County, North Carolina.

During the next 10 years, 186 counties in 23 states organized full-time health units. Such units comprise at least three workers, a health officer, a laboratory technician and sanitarian, and a nurse.

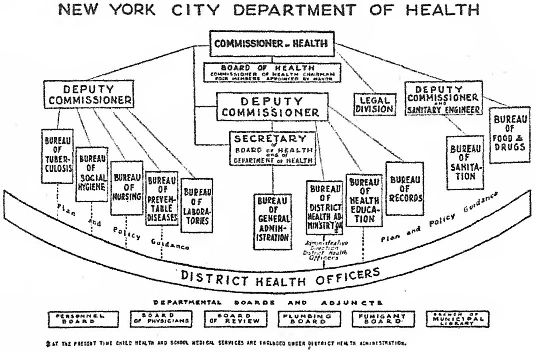


FIG. 94.

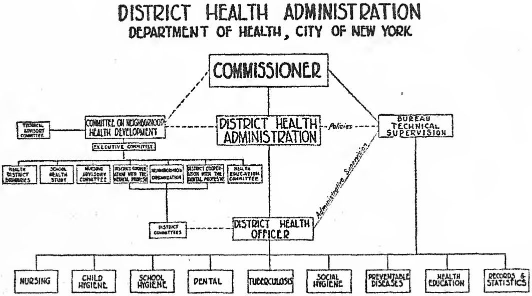


FIG. 95.

The extraordinary growth of county health organizations had been due in large measure to the Rockefeller Sanitary Commission, and to the United States Public Health Service. The former went into rural districts to help eradicate hookworm disease. The latter was especially concerned with typhoid fever. Under the influence

of these two organizations, and with financial aid and the loan of personnel from them, many counties were enabled to start health work, and later to carry it on by themselves, or with the help only of their own state or of local non-official organizations.

By 1937, over 1,100 of the 3,000 counties in the country had been organized for full time health work. In 6 states, every county was so organized. In all the recent county health work, the counties themselves have borne most of the expense, and administered the work with excellent results.

An interesting aspect of county work has been the Rural Conservation Contests, conducted by the United States Chamber of Commerce and the American Public Health Association.

Our population is about half rural—that is, half of the population lives in towns of less than 2,500. The fact that this large portion of the population is now better served is at least partly responsible for our good health records in recent years.

In this connection, it might be mentioned that some of the medical schools have made particular efforts to prepare physicians for rural practice, and some of the foundations have offered scholarships to students in medical schools provided they would settle in rural districts.

United States Public Health Service.

It will be recalled that the Federal government has the rights granted to it under the Constitution, and that whatever rights are not specifically granted to it are States' rights.

Under the Constitution, the Federal government has the power to provide for the common defense and general welfare of the United States. Also it has the specific power to regulate commerce with foreign nations and between states, and the specific power to levy taxes. With these powers, the Federal government has been able to do a great deal of work for the health of the nation as a whole. Its health work has been done through a number of different divisions of the government, chiefly through the Public Health Service.

The Public Health Service began as a service for merchant seamen, comparable to the medical corps of the Army and Navy, with medical officers of military rank and title. Its work was that of conducting hospitals for the merchant seamen and also of regulating maritime quarantine at all ports so as to check the entrance of disease from other countries.

In 1890 it was given control over the interstate spread of the four communicable diseases, cholera, yellow fever, plague and

U. S. PUBLIC HEALTH SERVICE

AS OF
OCTOBER 1, 1939

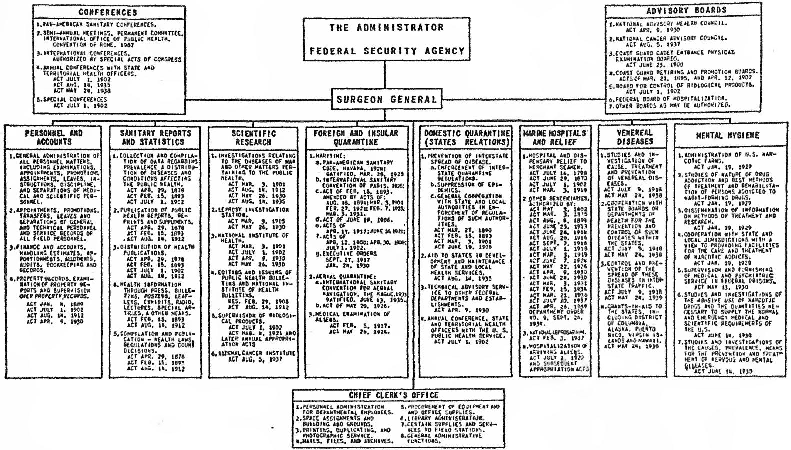


FIG. 96.

smallpox. In 1893, it was empowered to deal with all diseases as matters of interstate commerce, and also to cooperate with state and local authorities in any matters of disease control.

In the same year, 1893, its Hygienic Laboratory, now called the National Institute of Health, was founded. It is probably the most important public health organization in the world. It has laboratories in Washington and elsewhere, and investigates disease all over the country. It has studied and solved many disease problems.

Briefly, the work of the United States Public Health Service may be summarized as follows: *publication of reports* regarding outstanding public health problems that concern a considerable portion of the population; *financial aid* to states and counties in the development of their health work, such aid being temporary until the state or county can continue the work at its own expense; *educational aid*, by way of demonstrations conducted to show the effectiveness of a given approach to a health problem, in which case the entire cost may be borne by the Federal government (e.g. the venereal disease program); *assistance* to any state in times of epidemic; *quarantine control*, both international and interstate; *standardization of biological products*, ensuring their purity and their potency, by means of inspection of plants, testing of products, and the licensing of manufacturers who conform to its high standards; *conducting of hospitals*, such as those for mental disease, drug addiction, and leprosy; and finally, *scientific research* of any kind regarding any type of disease.

International Public Health.

As far back as 1851, an international sanitary conference was held in Paris. It was not, however, until 1907 that a permanent organization was established—the International Office of Public Health, located at Paris. Its council soon included representatives of 52 governments. From the first, its work has been chiefly concerned with the epidemic diseases, upon which it collects statistics and data, and regularly issues reports. Also, it supervises the regulations comprising the International Sanitary Convention, adopted as a code in 1926.

Further work for international health was begun in 1920, when the League of Nations established its permanent Health Committee to direct the work authorized in Article 23 of the Covenant.

The two international organizations work in harmony, and both provide much information and technical assistance to nations all over the world.

PART 5

HEALTH CONSIDERATIONS

Chapter 19

FOOD

A. QUANTITY

The most obvious need for food is a quantitative one. To obtain *enough* food is man's perennial search. In this respect modern man is no different from his primitive ancestors, whose nutritive aim may well have been that of obtaining food—any food—in sufficient quantity to keep him from starving and from suffering the pangs of hunger, and to give him strength to hunt for more food for the same purposes. His life must have been more or less a round of getting food in order to have strength to get more food, and so on. With luck, he may have found that which pleased the palate as well.

Even today, the total quantity of food is not only the most obvious, but also the most fundamental aspect of diet. It is a logical point at which to begin considering the diet, although, as will later be shown, it is not a logical point at which to stop considering it.

Appetite as a Guide.

There are several ways of deciding how much food to eat. The first is the simple one of satisfying hunger. As far as the total amount of food is concerned, hunger and appetite are fairly reliable guides in the case of the normal person whose senses are not in any way perverted. But there are many who would eat too much or too little for health if they or those in charge of their diet did not measure the intake by other standards than inclination.

Weight as a Guide.

The second way of estimating how much food to eat is by the use of the scales. In a full grown adult, if the weight is normal and remains so, it is commonly taken as evidence that the amount of food taken is correct. Again, insofar as total intake is concerned, the scales may be a safe guide for the normal well adult but may not be reliable in all cases. This subject is discussed in Chapter 24.

Caloric Computations.

For many reasons, it is preferable to compute the total amount of food to be taken daily according to mathematical principles.

This may be accomplished by computing how much energy the foods supply, and how much energy the body uses; and then matching these two amounts.

Foods are combustible substances—that is, they are capable of uniting with oxygen and giving off heat, just as all fuels do. Heat is convertible into any other form of energy. Therefore, the energy value of food will be the amount of heat it yields when it burns. The unit of heat is the calory. One calory is the amount of heat that will raise one pound of water 4°F.

Food in general consists of three combustible substances, called foodstuffs because they are the "stuff" or bulk of food. They are protein, carbohydrate and fat. When these undergo combustion in the body they yield the following:

Foodstuff	*Calories per Gram*
Protein	4
Carbohydrate	4
Fat	9

The various foods in general consist of combinations of these three foodstuffs. All the common foods have been analyzed, and the average percentage of each food-stuff has been determined. Therefore it is a fairly simple matter to compute how much of a given food would be required to yield a given amount of heat or energy. The caloric value of a number of foods is given in Appendix I and II.

Basal Caloric Needs.

The other aspect of the calory problem is to find out how many calories the body needs—that is, how much heat or energy it uses. This, too, has been computed for large numbers of individuals at rest and at various kinds of work. The method consists of finding out how much oxygen is used and how much carbon dioxide is given off during a given period. These figures represent the amount of combustion that takes place, which is equivalent to the energy that has been made available and used. The instrument for making such computations is called a calorimeter.

The results of calorimetry show that it takes about 1400–1700 calories merely to keep living while completely at rest. These calories provide for the body heat (keeping its temperature at the normal level of 98.6° F.) and for the vital processes such as breathing and the beating of the heart. At this low level of chemical exchange and of bodily activity, the conditions are said to be *basal*, and the

number of calories needed represent the basal requirement for life. The basal metabolism, it has been discovered, varies according to the size of the individual, with reference to surface area. Also, it varies according to sex. For both reasons, the lower of the two figures given is a fair average for a small woman; and the high figure, for a large man.

Additional Caloric Needs.

With the basal requirement as a starting point, the next step is to ascertain how many additional calories are necessary to carry on activities. Tests have been done to determine the amount of energy used in almost every conceivable activity. Some of the figures are shown below.

Activity	*Calories per Hour*
Lying at rest	65
Writing at desk	100
Standing at rest	105
Singing	120
Typewriting, moderate speed	125
Carpentry, light	240
Walking, briskly	300
Sawing	475
Running	570
Digging excavations	600
Football	600

The total number of calories used at the various levels of activity will be the 24-hour use of energy and, ordinarily, the 24-hour caloric requirement for food.

By reference to the tables in the Appendix, it will be seen that 26 pounds of lettuce, or ¾ pounds of walnuts, or 2 pounds of bread without butter, or ⅔ pounds of butter without bread will furnish a day's ration for a person requiring 2400 calories. Clearly, none of these articles alone would be a satisfactory diet from the point of view of appetite. Man has always throughout history preferred a variety of foods when such were obtainable, the variety being chosen according to appetite.

Non-caloric Needs.

A popular choice of food is somewhat as follows: a breakfast of cereal, toast and coffee; a lunch of meat sandwiches and a cup of coffee; a dinner of meat and potato, bread and butter, pie and coffee. Multitudes of people throughout the world, if asked whether that diet was satisfactory would answer in terms of quantity, saying that it would be satisfactory if enough of it were taken. They would expect a person on such a diet to look well and feel well and to be

full of vitality; but they would be wrong. Enough is not enough unless it is of the right kinds. Foods have other properties than combustibility; the body has other needs than for energy.

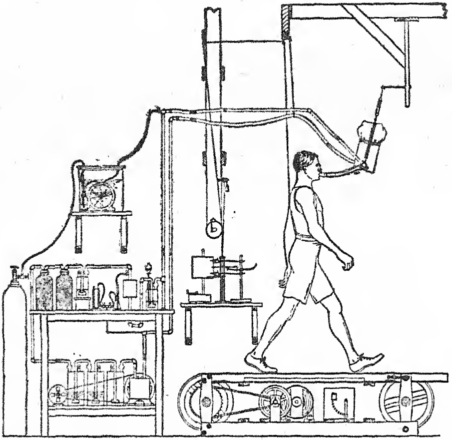


FIG. 97.—Apparatus (calorimeter) used to determine the number of calories used in walking. (Courtesy of Dr. F. G. Benedict, and the Carnegie Institute of Washington.)

B. NUTRITIVE PROPERTIES

In choosing the daily dietary it is necessary to know what the other nutritive properties of foods are besides combustibility; and to know what the body's other nutritive needs are besides the need for a given number of calories. Then, just as one tries to match the caloric value of foods to the caloric needs of the body, so can one try to match the other nutritive values of foods to the other nutritive needs of the body.

The Nutritive Cycle.

The materials available for man's food come either from plant life or animal life. In the latter case, the ultimate source is plant life upon which animals have nourished themselves. To go still farther back, plants derive their nourishment from the soil and the atmosphere.

When conditions of light and temperature are correct, green plants combine water and carbon dioxide from the atmosphere to form carbohydrates (glucose and starch). From carbohydrate they can also make fats. Taking up minerals from rock, and nitrogen from materials returned to the soil from decaying plant and animal life, plants can also make proteins.

These three compounds are formed only under the influence of sunlight. The heat energy of the sun which is used in making these compounds is said to be stored in them, because the same amount of heat that has gone into making them can subsequently be released when they combine again with oxygen. In other words, the sun has made them into combustible substances, with potential energy locked up in them.

Plants use some of their potential energy for their own life processes, but much of it remains stored in them. Therefore they may be burned to give heat or energy under any circumstances in which sufficient oxygen is available. When eaten by animals, the three compounds yield calories for the animals' activities, including the process of growth. Within the animal body, the plant proteins, fats and carbohydrates are built up into the structure of the animal, becoming the animal forms of these substances.

It will be seen that the nutrition of humans is one phase in a vast cycle of life and energy. The food that man needs is that which he can use to *build up his protoplasm.* He cannot, like plants, take the elements and convert them into his own substance. But he can take the materials already formed in plants and in other animals, and use them for his nutritional purposes. The question is, just what are his nutritional needs and from which sources, plant or animal, can he best meet them? To answer that question, the make-up of the human body must be briefly reviewed.

Synthesis.

All living things have nutritive needs—that is, they require substances from outside themselves to enable them to survive and carry on their life processes. In all, the process of nutrition is fundamentally the same. It is a process of synthesis (*syn*, with or together; *thesis*, placing). According as it receives the necessary materials, any plant or animal can take food substances and synthesize them into its own protoplasm.

Nutrition is a process that goes on in the individual cells of the plant or animal, but the total result is that the organism as a whole will thrive if all its individual cells are provided with everything that they need for their constructive metabolism.

Human Synthesis.

The human body needs to synthesize, or "place together," many substances in order to keep itself in running order. It needs substances to form its *protoplasm*, of the form found in the different kinds of tissues, each with somewhat different chemical needs. Also, it needs substances to form its *fluids*, such as the blood plasma and lymph. These fluids provide the internal environment of cells and they must be of the right composition or cell life cannot go on normally, if at all. Finally, the body needs the necessary chemicals for its cells to make their *products*, such as the digestive enzymes, and the endocrine hormones.

Some of the substances that are needed in the body do not actually enter into the structure of the body, but take a vital part in various physiological and chemical processes.

The need for material from which protoplasm can be formed during the growing period of life is obvious. Less obvious is the fact that throughout life protoplasm is daily being worn away and must daily be renewed or rebuilt. Still less obvious are the other chemical needs mentioned. They would hardly be suspected except as a result of detailed study.

Information regarding nutritive needs of the body comes partly from knowledge of its composition and of what is daily given off. Also, it comes from study of biochemical processes, such as osmosis, and from study of physiological processes such as the heart beat. In many cases, it has been determined very accurately what chemicals must be present to favor normal chemical exchanges and normal functions.

Many of the nutritional needs of the body have been learned only as recently as this century, and new knowledge is being gained every day.

Thirty-six Dietary Essentials.

At the present time, it is thought that there are at least thirty-six elements or compounds that are indispensable in the diet for life and growth and the correct performance of hundreds of special processes. If any single one of the thirty-six is lacking, it is likely to interfere with the use that can be made of all the others. Therefore any slight degree of failure to meet nutritive needs is likely to result in diffuse failure of the whole nutritive process.

Good nutrition, then, means adequate supplies of all sorts for all cells. The end result will be an organism in good "running order." However, it is not the case that good nutrition can always

be obtained by taking the proper diet; too many other factors enter into the matter of maintenance of bodily structure and function (e.g., sleep). It is certainly true, however, that without a diet that supplies all the dietary essentials, nothing can be hoped for in the way of health or vitality.

Protein

Nitrogen.

Of all the elements contained in protoplasm, nitrogen is the characteristic one. It is absolutely essential to life. A considerable amount of nitrogen is given off daily, as urea and other nitrogenous compounds in the urine. Therefore an equal amount must be supplied daily, in order to keep the nitrogen balance correct.

In ordinary circumstances, the amount taken in and the amount given out must be the same. In some circumstances, however, more must be taken in than is given out, i.e., there must be a positive nitrogen balance. This is the case, for example, during pregnancy, and in some other circumstances when construction is going on in the body. A negative nitrogen balance occurs in some of the debilitating diseases, when wastage of protoplasm is great, and in such cases, it is important, if possible, to restore nitrogen balance by an increased intake of nitrogen.

Nitrogen as such cannot be used by the body. The body is not able to construct protoplasm from pure nitrogen, but only from compounds called amino acids.

Amino Acids.

Amino acids are the compounds that make up protein—the characteristic substance of which protoplasm is made. They are the "building stones" from which the human body forms its protoplasmic structure. Protein food is digested to the stage of amino acids, and these circulate to, and are absorbed by, the various tissues, where they are broken up and their elements re-arranged to form tissues and fluids.

Twenty-five or more amino acids have been identified, and ten of these are thought to be absolutely essential for health and some for life itself. They are: cystine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, and valine.

Apparently all the essential amino acids must be present in circulation at the same time if synthesis of protoplasm is to be complete.

Since there is no real storage place for them in the body apart from the tissues and fluids they form, there is no place from which

they can be drawn in emergency without detriment to tissue integrity. Therefore they must be supplied from day to day.

Each amino acid contains part of the necessary supply of nitrogen, and also each contains some of the other substances necessary for life. All together, the amino acids afford the materials to form human protein such as exists in the body cells, and in the blood and other fluids.

The relative value of the various amino acids has been determined by giving them individually in highly purified form to experimental animals. The other amino acids are not indispensable, since they can be synthesized in adequate amounts in the body from the materials available there. However, in certain abnormal conditions, one or another of the amino acids will not be synthesized as usual, (e.g., glutamic acid and glycine in a disease of the muscles), in which case these become indispensable in the diet.

Since purified amino acids may be obtained in the laboratory, and be given in measured amounts, exactly to meet nutritional requirements, precise control of this important aspect of nutrition is becoming a possibility in the case of those who cannot obtain amino acids in the usual way through a variety of protein foods.

Protein.

From what has been said, it will be clear that protein is essential in the diet, to furnish the necessary nitrogen in the form of amino acids. It should be noted, however, that the value of amino acids is not exclusively that of nitrogen. They all contain various other elements and compounds which together cause proteins to be the foundation of the diet.

The protein molecule is an extremely large one. Besides containing carbon, hydrogen, oxygen and nitrogen, it also contains sulphur, phosphorus, and fifteen or more other elements. Some of these will be specifically discussed below.

The *kind* of protein that is needed is determined by a knowledge of the amino acids each contains. It is known that many proteins furnish all the essential amino acids; they are called proteins of the first class. Other proteins lack one or more essential amino acids (e.g., the protein of corn lacks two, and gelatine lacks three); these are proteins of the second class, and although they may be useful in the diet, they will not by themselves support life.

In any given article of food that contains protein at all, usually there will be several proteins. Therefore, for practical purposes, a diet that contains the requisite total amount of protein will usually

supply the necessary kinds containing the necessary amino acids and other compounds. However, in a restricted diet this is not necessarily true.

Proteins are available from animal and from vegetable sources. In general, animal proteins contain more of the essential amino acids. If only plant proteins are taken, it will be necessary to take a larger variety of them, and also a larger total quantity, in order to meet nutritional needs.

The *amount* of protein that is needed in the diet is determined in a number of ways, especially by studying the excretion of nitrogen (which forms 16% of protein). It has been learned that a person may maintain nitrogen balance on as little as 25 grams per day, but physiologists do not recommend that the diet be thus restricted. Many people taking a diet so low in protein would begin to show wasting of the muscles, and perhaps a tendency for water to accumulate in the tissues and body cavities (unless salt and water were similarly curtailed). Also, digestive troubles sometimes occur in those on a low protein diet.

The required amount of protein is 50–100 grams per day. This can be conveniently obtained from the following foods:

Food	*Grams of Protein*
Milk, 1 quart	32
Lean meat, one serving	13–24
Egg, one	6
Bacon, three 5″ strips	7
Whole grain cereal, one serving	4
Bread whole grain, 4 slices	6
Cheese, one 1″ cube	6
Beans or peas, one serving	10
	84–95

There need be no fear of taking an excess of protein, for the protein not used to synthesize protoplasm or to furnish energy is de-aminized and excreted as urea and ammonia in the urine, or in other ways broken down and excreted. The caloric value of protein is due to the fact that 60% of the protein molecule can be turned into glucose and used for energy production. From 100 grams of protein per day, 400 calories of energy would be obtained.

Meat usually digests well, and is a physiologically economical source of nitrogen and amino acids. It does not cause high blood pressure or any other of the grievous calamities that popular superstition has associated with it. Red meat and white meat belong in

the same category. As will later be shown, meat is an important source of certain essential minerals and vitamins.

There is apparently no danger for the normal person in eating too much meat. Schenk's study of the diet of those participating in the Olympic games in 1936 showed that the average intake was 7,300 calories, as follows:

320 grams protein (some as high as 600–1000 grams)
270 grams fat
850 grams carbohydrate.

Fish is a good substitute for meat as a source of protein, and also of certain minerals. Because it is less concentrated than meat (i.e., contains more water), larger servings are necessary to obtain the same amount of protein.

Carbohydrate

The carbohydrates are starches and sugars. The greater part of the carbohydrate existing in the body is in the liver and the muscles, in the form of glycogen (animal starch) and in the blood as glucose (a sugar). Since these substances are used in combustion daily, and to some extent enter into the architecture of protoplasm, a daily supply must be furnished in the diet.

In the normal person, an excess of carbohydrate in the diet is stored in the liver and muscles up to their capacity (500 grams), or is converted into fat and stored among the tissue cells in the various fat storage places. The amount of carbohydrate in the diet is subject to more variation than that of the other foodstuffs, the variation occurring according to the need for energy. Usually four or five times as much carbohydrate as protein will be required.

Foods contain varying amounts of carbohydrate. *Sugar* occurs naturally in a number of foods (e.g., lactose in milk; fructose in ripe fruits; sucrose in vegetables). It is also taken in the pure form as cane, corn or maple sugar (either in granules or as syrup) and in foods sweetened with these sugars. Sugar being a purified vegetable product, contains no other dietary essentials.

Starches occur abundantly in nature in plant tissues, and to less extent in animal tissues. The main source of starches in the diet are the cereal grains and flours, and potatoes. In the same substances that are rich in carbohydrates there may also be many other nutritive essentials. Therefore the starchy foods are not so exclusively of caloric value as the sugars; in fact, many starch-rich foods are also important sources of several other dietary essentials.

Although everything necessary to the body might be furnished from other sources than carbohydrate, it is still true that carbohydrate is essential in the diet, for without it fat cannot be properly oxidized. The only exception is in the case of the carnivora, who obtain enough carbohydrate from the breakdown of protein.

Fat

Fats are essential in the diet, because fat is a constituent of all cells. Serious results follow total deprivation—or even partial, for a long period. Also, fats, both vegetable and animal, are good sources of energy, since they occur in foods in high concentration, and furnish 9 calories of energy per gram.

Fats are used in the body either as fat or as their component molecules, fatty acids. Regardless of the kind of fat taken in, the body appears to be able to use the various fatty acids to make its own fatty tissues.

As to the amount of fat needed per day, the proportion is about the same as that of protein (i.e., 50–100 grams). Beyond that point, it appears that fats are neither appetizing, nor well digested, nor beneficial to the tissues.

Fat occurs in the diet in butter, cream, egg yolk, cheese, salad oils, bacon and other fatty meat and fish, nuts, olives, chocolate, and in foods made with fats, such as gravy, icecream, cakes and similar "rich" foods. It should be noted that much of the fat in the diet is not apparent as such.

Minerals

A large number of minerals enter into the formation of the body. Animal tissues when burned yield an ash containing the following:

iron
sodium
potassium
magnesium
calcium
phosphorus
sulfur
chlorine
iodine
fluorine
cobalt
lithium
barium
manganese
aluminum
copper
silicon
bromine
zinc
nickel
tin

Most of these occur as inorganic salts in the cells and the body fluids. A salt is a compound of a base and an acid. The most familiar is sodium chloride or "common salt."

There is a constant turn over of some of these minerals; many of them are lost in appreciable amounts daily in the excreta and sweat (a total of 30 grams), and must be replaced either as the salts themselves, or as materials from which the body can construct salts.

While in the body, some of the inorganic salts are built into the structure of cells and tissues (e.g., calcium into bone), or into cell products (e.g., chlorine in gastric juice). Others enter into chemical reactions, with regulative effect—for example, certain salts are necessary for the normal irritability of nerve cells and muscle cells.

In mineral starvation from lack of salts in the diet, death comes more quickly if food is given than in the absence of food, since salts are necessary for the *utilization of food.*

One of the most important functions of salts is that of maintaining a suitable internal fluid environment for cell activity, especially that of regulating *osmotic equilibrium*, or the passage of substances in to and out from cells. The concentration of salts within the cell and in the fluids outside it determines which way fluids pass. If there is a lower concentration of certain salts in the fluid outside the cell, too much fluid passes into it and it is destroyed. Four of the minerals are necessary in an exactly balanced proportion in the cell environment: sodium, potassium, chlorine and calcium.

In the body the *balance of acids and bases* is of great importance, and the mineral salts serve to maintain the body in its normal slightly alkaline state, neutralizing the acids produced as a result of metabolism.

A large number of the laboratory tests done by physicians in the case of illness are for the purpose of keeping a check upon the balance of inorganic salts. To maintain this balance is often a crucial matter before and after surgical operations, and in any conditions in which mineral metabolism is, or may become, abnormal (e.g., in pregnancy).

At least fifteen minerals are known to be indispensable for body functioning. Each specific mineral is believed to have its specific role. Many of them are needed in only the smallest amounts, but the extent of the need is not measured by amount.

Fortunately, the foods commonly chosen for the diet will supply an adequate amount of the necessary "ash substances," if the diet is *sufficient in amount and variety*. Only two of the minerals are thought to be deficient in the average diet in this country—calcium and

iron. A third, iodine, is deficient in many inland diets. Some authorities believe that there may also be a shortage of phosphorus.

In the case of those who cannot take or assimilate foods containing them, or in certain cases of special need, the necessary minerals can be provided as medicine.

Calcium.

There is normally in the body an exact balance between calcium and its partner, phosphorus, and two other electrolytes, sodium and potassium. The chemical mechanisms for maintaining this balance, and thereby the stability of body tissues and fluids, are extremely intricate. A large variety of clinical symptoms appear in disturbance of calcium metabolism.

A marked deficiency of calcium causes a condition called *tetany*, in which the muscles twitch and convulsions may occur. It is due to undue excitability of *muscle and nerve tissue.* It is reported that the ancient Chinese used ground dragons' bones as medicine for convulsions, thus antidating by thousands of years the modern use of calcium for the spasms of tetany.

Lesser degrees of calcium shortage may cause lesser degrees of neuromuscular irritability. Jacques Loeb suggested that without enough calcium we should all be "jumping around like jumping-jacks all the time." Others believe that it is not "modern times" but calcium shortage that accounts for the many symptoms included under the heading "*nervousness*."

Through its effect upon muscle and nerve tissue, lack of calcium may produce symptoms of *faulty heart action;* a due amount of calcium is necessary for the regulation of the tone and the beat of the heart.

The mechanism for the *clotting of blood* requires a sufficiently high percentage of calcium in the blood.

Sherman has said that a calcium-poor condition probably plays a large part in a number of *weaknesses* and increased *susceptibilities to infection*, without being exclusively responsible for any of them.

The layman is more familiar with the need of calcium for the *formation of bones and teeth.* It is calcium, in combination as phosphates and carbonates, that give them their hardness. The utilization of calcium for this purpose requires the presence in the body of sufficient vitamin D. All utilization of calcium in the body is governed by the parathyroid glands, with certain related glands.

In normal conditions, 36 grams of calcium are stored annually from birth to the sixteenth year, to supply the needs for growth. In

adult life calcium comprises nearly 2% of body weight—a much greater percentage that of any other mineral.

The calcium stored in bones represents to some extent "live storage"—that is, it may be slowly given off from the bones to the blood if blood calcium falls below the minimum for an extended period.

Calcium is constantly being excreted from the body, through the kidneys and intestine. During lactation it is also excreted in milk. The daily need for calcium is as follows: women during pregnancy and lactation 1.4 grams; children, from 0.75 grams to 1.0 gram according to age (the younger, the more); normal adults, 0.68 grams. The average American dietary is said to supply 0.48 grams.

Milk and cheese are two excellent dietary sources of calcium. Other foods furnishing calcium are eggs, many vegetables, especially dried beans, nuts, etc. An adult who takes three or four glasses of milk, one egg and several vegetables daily will be well supplied with calcium.

Phosphorus.

The amount of phosphorus needed in the body daily is about 1.58 grams per day, which is the amount present in the average diet. However, the need for phosphorus is greater during pregnancy and lactation and in some illnesses.

Since an excess of phosphorus is harmful, additional needs for phosphorus should be met only according to a physician's advice. Self-prescribed tonics containing phosphorus might upset mineral metabolism. Many such tonics are on the market, often recommended as "nerve foods." It is true that phosphorus in fatty compounds such as lecithin is an indispensable constituent of nerve cells, but the layman is not able to diagnose or prescribe for the chemical needs of his nerves.

Important as phosphorus is in the body—and the oxidation of a phosphorus compound may be the basic source of all energy in the body—its importance need not be further discussed, since those who take an ordinary diet, with sufficient animal protein, will have met their phosphorus needs in times of health.

Iron.

The need for iron has long been appreciated. It has been used for anemia throughout history. In ancient Greece, it was customary to drink water in which a sword had rusted, in order to gain the strength of the sword. Because of this tradition, early pharmacologists referred to iron preparations as "salts of Mars."

In his book entitled "Joyfull Newes Out of the New-found Worlde," published in 1596, Nicholas Monardes called iron "a most excellent metal which hath great medicinall virtues. . . . The powder of iron is profitable for them that hath a naughtie yellow pale color in the face."

The iron in the body amounts to about one-tenth of an ounce, being contained in the hemoglobin of red blood cells and muscles. It acts as an oxidizing agent; it is capable of taking up oxygen from the air in the lungs, which it later releases to the body cells for their oxidative purposes. Many red blood cells are destroyed daily; some of the iron in them is retained in the body, but some of it leaves the body in the intestinal secretions. Therefore, iron must be supplied daily in the diet. Shortage of iron produces the disease anemia. Although anemia is due to other causes, as mentioned in Chapter 26, it is often wholly or partly due to a deficiency of iron in the diet.

The need for iron begins before birth. At that time, and during the nursing period, the infant receives iron from the mother, if her diet is satisfactory. The artificially fed infant soon loses the supply of iron with which it was born, and must be given additional supplies, since the percentage of iron in cow's milk is very small.

At least 15 milligrams of iron should be furnished daily in the diet. Women need more than men because of the periodic loss of iron in the menstrual flow. In one series of tests, anemia from lack of iron was found to be present in 70% of adult women. Since there is no danger of taking too much iron in the diet, it would seem wise in the case of women to increase the daily intake to 20 milligrams.

Although iron is present in a great many foods, it is not in an equally available form in each. Good sources of available iron are the following:

Food	*Milligrams of Iron per 100 Grams*
Molasses	6.1
Liver (beef and calf)	5.6
Oysters	5.2
Oatmeal	4.6
Apricots	4.0
Lean beef	3.5–4.4
Egg	2.5–3.0

Many other foods, including a large variety of vegetables and fruits, contain iron in available form.

The same foods that contain iron also contain other minerals—copper, zinc, cobalt, and nickel. These seem to be necessary to make iron effective in the body, and for other purposes.

Copper has been recognized as a dietary essential. It appears to be indispensable in nearly all living cells. Rich sources of copper are oysters, liver, and the legumes.

Cobalt is always found with nickel in the same foods containing iron. It is a nutritive essential, having an oxidative function and possibly a special function in the pancreas.

Zinc is found in crystalline insulin from the pancreas, and appears to be important in giving insulin its effectiveness.

In providing for the body's need for iron, the need for these three minerals will also be met.

Iodine.

Iodine is one of the elements that is present in the body in very minute amounts. It comprises only one-three-millionth of the body weight—an amount that could be held on the head of a pin. Yet this small amount is essential to life. Most of it is contained in the thyroid gland, which uses it to make its hormone.

Without knowing what they were using, physicians in antiquity used iodine for thyroid gland deficiencies; it is reported that in ancient China and Egypt burnt sponge, which we now know contains iodine, was used for much the same purposes as iodine is used today. Galen in the second century wrote of the same treatment.

The need for iodine is easily met in regions near the sea, for the drinking water and also sea foods and food grown in soil near the sea contain a sufficient amount. In inland districts the lack of iodine in the water and in foods grown locally can be met by taking fresh, canned, or preserved food from salt water districts, or by the use of iodized salt.

Sodium and Chlorine: Sodium Chloride.

In the diet, and also in the body to a considerable extent, sodium and chlorine exist together as the compound known as common salt. Sodium itself is present in the body to the extent of a pound or more.

Sodium chloride is a compound of the greatest importance in the body. Its loss is one of the most harmful factors in the case of burns over a large area through which blood serum seeps out from the denuded tissue. Much salt is given off from the body in sweat; therefore, when sweating heavily, it is well to add a little salt to drinking water, especially when doing hard muscular work in hot weather. In certain illnesses, and often after an operation, salt solution must be supplied to the blood through the colon, the skin, or a vein.

Most living things, animal and vegetable, contain salt, therefore the diet will ordinarily contain a reasonable amount. More is often added to improve the taste of food. However, an extra amount is not absolutely essential in most cases. Dogs on an exclusively meat diet thrive without added salt. Too much salt in the diet, however, is not harmful to the well adult but might be so to an infant or to a person with damaged kidneys.

If too much salt is taken it usually increases thirst, which leads to an excessive intake of water. This temporarily increases the weight. Conversely, a salt free diet may reduce weight to the extent that it causes less intake and retention of fluid temporarily; it is not a "reducing diet" in any other sense of the word.

Potassium.

The balance of sodium and potassium in the body is of the utmost importance. There must be enough of each and in exactly the right proportion. Potassium is found in the body to the extent of a pound or so. Among its effects are those of giving elasticity and excitability to muscles and nerves. It is doubtful whether potassium is lacking in the average human diet that is sufficiently varied.

Various Inorganic Salts.

Sulphur is an essential constituent of all cells. Also it serves oxidative purposes. Since it is present in all protein food, additional supplies are not ordinarily necessary.

Manganese is one of the dietary essentials. It accelerates the action of the enzymes having oxidative functions, and appears to be essential to the use of vitamin B. In animals the lack of it deprives the female of "mother love." Apparently it is related in some way to certain endocrine functions, especially those governing reproduction and lactation.

Magnesium, the chemical used for flashlight photography because it burns so brilliantly, is a dietary essential. Laboratory experiments show that a shortage of magnesium causes animals to become nervous and that a complete lack causes convulsions. Certain French investigators believe that it often may be deficient in the diet. Opinion in this country is that if the total caloric intake is 2500, a shortage of magnesium is unlikely. Although magnesium is present in many foods, it may be deficient in products of soil in which magnesium is low, and in highly refined foods.

Fluorine is normally present in the body in bone and in the enamel of teeth, where it appears to be essential. An undue amount

of fluorine in drinking water in certain regions of the country has been found to cause mottling of the enamel of teeth. Conversely, it has been suspected that a deficiency of fluorine may cause susceptibility to decay.

Bromine has been found in certain parts of the brain. Zondek has suggested that its release from these areas may be responsible for falling asleep, the effect being similar to that of bromides used as sedative medicine. A small amount of bromine is given off in the sweat from some individuals.

Dietary Sources of Minerals.

It will be noted that the main sources of all the minerals are: meat, liver, eggs, milk, cheese, and vegetable products. Minerals are lost to a considerable extent by the refining of certain foods. They are lost by certain cooking processes—for example, by the boiling of vegetables; the cooking water holds the lost minerals, and should be used for making soup. Since canned foods are cooked after being put in the can and sealed, the minerals remain in the food or the juice. Therefore canned foods are often a better source of minerals than fresh food not properly cooked. Minerals are not lost by storage at atmospheric temperature or lower.

Vitamins

Vitamins are chemical compounds present in many foods in minute amounts and having important effects upon nutrition. In general, they act as regulators of one or another chemical process or physiological function. Some of them are absolutely essential to life.

The knowledge of the existence of vitamins came about as a result of the observation that laboratory animals did not thrive equally well on diets that presumably were of the same composition in respect to all the substances known at that time. Lunin, in 1888, commented on the fact that some of his animals were apparently not able to live on a diet containing protein, fat, carbohydrates, salts, and water unless the diet contained milk. He suggested that "*other substances indispensable for nutrition* must be present in milk." This is the first reference to these "other substances" we now know as vitamins.

About 1900, Ide of the University of Louvain, discovered that there was something in yeast that had not hitherto been suspected. He called this growth-stimulating substance *bios,* because it appeared to be essential to life.

In 1906, Gowland Hopkins, correlating all that was known about the additional substances in foods that were necessary to life and health, called them *accessory food factors.* In 1910, Casimir Funk gave them the name they now bear—*vitamins.*

Vitamin Deficiency Diseases.

The first work that led to the discovery of a specific vitamin was begun in 1897 by Eijkman in the Orient, in an attempt to discover the cause of a nerve disease called beriberi. He found that the diet of those who had the disease consisted chiefly of polished rice. By experiments with chickens it was discovered that the disease could be induced by a diet exclusively of polished rice, but that it could be prevented or cured by adding to the diet the material that had been removed in the polishing process. After a great deal of further research, the substance in the rice polishings the lack of which caused *beriberi,* was given the name vitamin *B.*

In the meantime, McCollum and Davis, in 1913 had linked a disease of the eyes, *xerophthalmia,* with the lack of a substance present in butter fat and egg yolk, but not present in olive oil or lard. This substance was called vitamin *A.*

At about the same time a third vitamin was found present in citrus fruits and certain other substances. The lack of it caused the disease *scurvy.* It was named vitamin *C.*

Then it was found that the same oils that contained vitamin *A* contained also another factor, which was called vitamin *D.* This vitamin was found to be necessary to protect against the bone-deforming disease rachitis, commonly known as *rickets.*

In each case, the discovery was made by tracing a specific disease to a specific lack in the diet. By including and excluding first one food and then another, eventually it became clear which foods contained substances that would protect against the disease in question. The diseases came to be known as *deficiency diseases,* and the vitamins were given adjectives with the prefix *anti-*, indicating that they were against the specific disease: vitamin A, *anti-xerophthalmic;* vitamin B, *anti-neuritic;* vitamin C, *anti-scorbutic;* vitamin D, *anti-rachitic.* More recently it was discovered that vitamin B contained a factor that protected against another serious disease, pellagra. This factor was called vitamin B_2 (or G), the *anti-pellagra* vitamin.

The foregoing are the major deficiency diseases, but the study of each of these vitamins and others has shown that there are many illnesses and symptoms due to lesser vitamin shortage, and that

these are in the aggregate perhaps as important as the diseases mentioned.

Vitamin A.

Vitamin A affects epithelial structures. The disease xerophthalmia occurs only in case of a marked deficiency of vitamin A. In lesser deficiencies the health of the skin and mucous membranes is impaired. Reports indicate that infections of the skin, the sinuses, other parts of the respiratory tract, the ears, and other tissues are more frequent in those who lack sufficient vitamin A. Beyond the necessary amount, vitamin A does not, however, increase resistance; nothing is to be gained by taking an excess.

A common symptom of even slight deficiency of vitamin A is impairment of vision in dim light. Normally, vitamin A is present in the retina of the eye, and takes part in the chemical changes which make it possible to adapt to dim light or to a reduction in the amount of light, as upon entering a dark room after having been in a lighted one. Where nightblindness is due to lack of vitamin A, it responds promptly to correction of the dietary deficiency.

Vitamin A is also highly important in promoting normal tooth structure in growing children, and possibly in adults.

Good sources of vitamin A are: liver, codliver oil, egg yolk, butter, fat, yellow vegetables and green vegetables.

Vitamin B_1.

The chemical name of vitamin B_1 is thiamin chloride. It is known to be essential for carbohydrate metabolism and for the health of the nerves and the intestines. Professor E. V. McCollom has declared that vitamin B_1 deficiency is one of the major health problems of the world. Similar statements have been issued by leaders in public health in many lands.

The deficiency disease beriberi is scarcely ever seen in this country. However, a severe form of vitamin B_1 deficiency is often seen in chronic alcoholics. When alcohol, or any carbohydrate, is taken to excess or relatively out of proportion to other substances, an extra supply of vitamin B_1 is necessary to aid in the metabolism of the carbohydrate. But instead of receiving more vitamin B_1 than usual, the alcoholic usually receives very much less, because of his restricted diet.

Among the common manifestations of vitamin B_1 deficiency are disorders of digestion, including constipation, and lack of appetite. Various nervous symptoms and chronic fatigue may also be due to lack of this vitamin. It is thought that many of those classed as

neurasthenic or neurotic may be suffering from this dietary lack, affecting both the nerves and the brain. In some cases of vitamin B_1 deficiency the symptoms are chiefly those of faulty heart action, of gradual or sudden onset.

The daily requirement of vitamin B_1 for adults is from 200–300 International Units. Since it is stored to very small extent, the supply must be furnished daily; symptoms of deficiency may occur after only five days' deprivation.

Extra supplies of vitamin B_1 are needed in high caloric diets containing much carbohydrate, and in fevers, during which metabolism is rapid. Also, pregnancy and a number of other conditions create special demands for this vitamin, which should be met only according to medical advice, however.

Good sources of vitamin B_1 are: whole cereal grains, liver, egg yolk, milk, beef, mutton, lean pork, oysters, nuts, many vegetables, and yeast.

The value of vitamin B_1 in growth has received a great deal of publicity owing to the discoveries of horticulturists of the spectacular results of administering minute doses to plants. A solution as dilute as 1 part per 100,000,000 is reported to have produced daffodils with blossoms as large as salad plates and tea roses with buds five inches long. By applying such a solution to the roots of trees and shrubs, it has been found possible to transplant them at any season of the year, since the vitamin prevents the customary "root shock."

Vitamin B_2 (or G): the B Complex.

Marked deficiency of vitamin B_2 causes the disease pellagra. It is a serious disease that prevails throughout the country to the extent of 400,000 cases, with 8,000 fatalities annually. The deficiency is incurred chiefly in districts in which corn is the main cereal food and fat pork the main meat, instead of whole wheat and lean meat.

The symptoms are numerous—a typical skin disorder; inflammation of the tongue and gums; disorders of the digestive tract, with diarrhoea; and, in marked cases, mental disease, mild or severe. Minor degrees of deficiency are responsible for the same symptoms in lesser degree. Even when well advanced, pellagra may be curable by a diet containing sufficient vitamin B_2.

It has been discovered that vitamin B_2 is a complex chemical compound containing not only the factor which prevents pellagra, but also a number of other vitamins. The former is chemically recognized as nicotinic acid. One of the others is riboflavin. It, too, is essential for nutrition. Deficiency of riboflavin causes inflammation

of the mucous membrane at the corners of the mouth and of the conjunctiva. At least one other vitamin of the B complex is also believed to be essential.

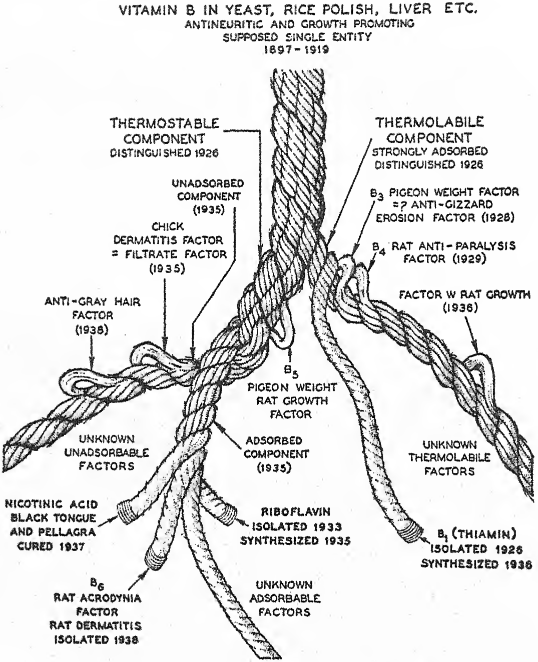


FIG. 98.—The vitamin B complex. (From Williams and Spies "Vitamin B_1 and Its Uses in Medicine," Courtesy The Macmillan Company.)

For the layman, an acquaintance with the numerous vitamins of the B group is scarcely practical, since foods containing vitamins B_1 and B_2, if taken in sufficient variety, will furnish the others that are necessary.

Vitamin C.

The disease scurvy occurred in epidemic proportions during the Middle Ages. It wrought great havoc among the Crusaders and the crews on the voyages of discovery. It cost Vasco da Gama 100 of his crew of 160 on his voyage around the Cape of Good Hope.

About 200 years ago John Lind and Sir Gilbert Bland, officers in the British navy, discovered that scurvy could be prevented by lime juice. The slang term "limey" has been applied to English sailors ever since, and the citrous fruits (oranges, lemons and limes) have been used ever since to prevent scurvy.

In 1928 vitamin C was isolated; its chemical name is ascorbic, or cevitamic, acid. It is found not only in citrous fruits but also in cabbage, potato, tomato and certain other vegetables, and in milk.

The main symptoms of lack of vitamin C are mental depression; dry, rough skin, appearing dirty; "laziness"; spongy bleeding gums; a tendency to bruise easily; swelling of the lower legs and of the joints; shortness of breath; and anemia.

It is believed that vitamin C is important in preventing and curing certain infections. In the laboratory, vitamin C will inactivate diphtheria bacilli and the virus of poliomyelitis. Clinically, the use of vitamin C is helpful in treating some infections but not others. It appears to be of particular value in wound healing. It has been shown that the leukocytes contain a relatively large amount of vitamin C. Most of those ill with infection have low levels of vitamin C, which may partly account for their having become infected.

Athletes and manual laborers need a great deal of vitamin C. So also do diabetics and women during pregnancy and lactation. Artificially fed infants must usually begin to take orange juice at two weeks of age. Due absorption of vitamin C may be prevented by the habit of taking sodium bicarbonate or cathartics.

Vitamin D.

Vitamin D is formed in the fatty substance of animal tissues by the action of sunlight. It is essential to life and growth.

An important role of vitamin D in the body is that of regulating the amount of calcium and phosphorus the body uses in constructing bones and teeth (the process being under the direction of the parathyroid glands and an enzyme present in these structures).

Infants who do not receive enough vitamin D develop the disease rickets. The symptoms are flabby muscles, irritability, restlessness, delayed dentition, and changes in the skeletal structure. The legs become bowed, the chest deformed, and the wrists and ankles

enlarged. Such children are often fat, and their parents think them the picture of health until the deformities appear. In recent years outright rickets has become rather rare, but minor degrees, disturbing the normal process of growth and the symmetry of the body, are still common.

Adults who are sufficiently exposed to sunlight and who take enough milk, butter and eggs in the diet do not need extra supplies of vitamin D except in special circumstances—as, for example, during pregnancy, and when limiting the diet for reducing purposes. The situation is different, however, with infants and young children; they are not able to synthesize enough vitamin D from sunlight, nor to obtain the requisite amount in the small volume of food they consume, and therefore require codliver oil or the like.

Other Vitamins.

Although many other vitamins have been discovered, some of which are essential for the nutrition of various animals, only three of these are apparently important for humans.

Vitamin E has been found essential in animals for the normal development of the fetus and the completion of pregnancy. There is considerable evidence that it may be of value in humans for the same purposes, and also for others.

Vitamin K is concerned in the clotting of the blood. It has been isolated and synthesized, and is in use as medical treatment in certain diseases in which bleeding occurs.

Vitamin P is contained in substances that contain vitamin C. Apparently it has a somewhat different action, and it is believed to be essential in the diet.

These three vitamins will usually be present in a diet sufficiently abundant and varied.

Chapter 20

DIET

Sir John Orr, a leader in nutrition, expressed the opinion of all physicians when he said "We now know that faulty diet is responsible for a great deal of disease, ill health and physical disability which in the past were regarded as normal and inevitable."

To summarize what has already been mentioned, a diet may be a fault in the following ways: (*a*) the total quantity may be too much or too little; (*b*) the proportions of foodstuffs may be incorrect, not "balanced"; and (*c*) the nutritive essentials may not all be present in sufficient amounts.

Choosing a Diet.

It is comparatively simple to choose a diet of the correct quantity and proportions of foodstuffs, but many people have difficulty choosing a diet to contain all the nutritive essentials. The latter problem may be solved in several ways.

First, one may equip one's self with a thorough knowledge of the details of nutritive requirements and of food values. One who knows all the details can compute thousands of combinations of foods that make a satisfactory diet. For example, one physiologist computed that a diet of five slices of bread, butter and molasses, one quart of milk, two eggs and lettuce would give 2000 calories and the correct amounts of essential materials for adults. But the exact computing of a correct diet is virtually impossible except for those professionally interested in the subject, since the mass of facts is very extensive and constantly becoming more so.

A second method of obtaining a correct diet is not to choose it one's self but to partake of a diet provided or prescribed by a qualified person. This method is satisfactory for those living in institutions in which the diet is arranged by dieticians, provided the individual actually does eat all that he is supposed to eat; in omitting any of it, he might omit some of the essentials. To take a prescribed diet is the only method that is satisfactory in certain illnesses, as, for example, in diabetes.

A third method of planning the diet is that of taking a variety of foods, on the principle that in an assortment of foods the essentials

will be likely to be present. Certainly this is a good principle. Any varied diet is more likely to meet nutritional needs than an unvaried one if both are chosen in hit-or-miss fashion.

A fourth method—the most practical and satisfactory for the average person who is well or nearly so—is to take a diet varied according to scientific principles.

The Nine-Point Diet.

To make sure that nothing essential is omitted, it is desirable to partake of one item from each of the following groups daily, in appropriate quantities.

1. Meat (or fish, fowl or game)
2. Whole grain cereals (as cereal or as dark bread)
3. Milk (or foods made with milk)
4. Milk products (butter, cream, cheese)
5. Eggs
6. Green leaf vegetables (lettuce, "greens," etc.)
7. Root vegetables (potatoes, carrots, etc.)
8. Legumes (peas, beans, lentils)
9. Fruits* (or berries)

The only exception is in the case of legumes, which might not be necessary daily if other good sources of minerals and protein were abundant.

Variation is necessary within the groups of cereals, meats, the three kinds of vegetables, and fruits, since each of the members of these groups furnishes somewhat different nutritive materials.

As has been stated, a diet not in the least resembling one chosen on this basis might supply all dietary essentials, but for practical purposes in the case of those who are not equipped with detailed information, this schema gives excellent results.

Water.

Foods contain water, and water is necessary in the body. But one does not take food in order to obtain water; one drinks water as a beverage. Therefore the water content of food may be ignored, except as it might influence the amount of water taken as such. This subject is discussed in Chapter 22.

Cellulose.

Vegetables and fruits contain a non-nutritive and virtually indigestible carbohydrate substance called cellulose, commonly described as "bulk" or "roughage." It is essential in the diet, but it

* *Some fruits are eaten as vegetables (e.g., tomato, cucumber).*

need not be considered when the choice of foods is made from each of the nine groups mentioned above, since it will inevitably be present. The use of cellulose is mentioned in Chapter 23.

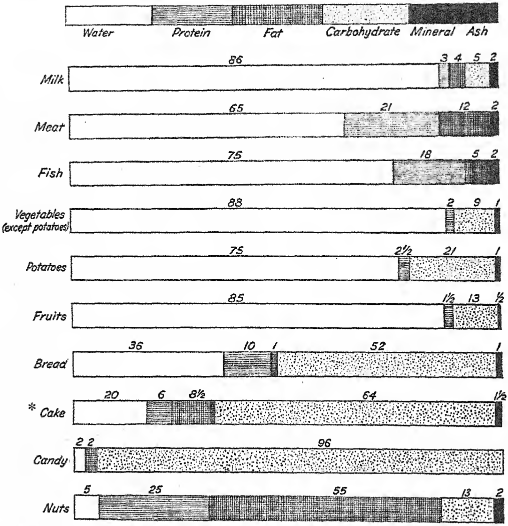


FIG. 99.—Diagram showing the average percentage composition of certain typical foods.

Milk.

Special mention must be made of milk, because it is a rich source of *calcium* and *protein*. A diet satisfactory in every other respect may fall short of meeting these two major needs if it lacks a due amount of milk. Milk should be taken in one form or another to the extent of one quart daily, by adults as well as by children. A pint a day is the minimum for an adult, and a quart is much better.

The amount of calcium and protein is the same in fresh milk, raw or pasteurized, skimmed milk, buttermilk, canned milk or dried milk.

* *Gingerbread was included with cake, which increased the percentage of mineral ash, owing to the iron in molasses.*

It should be noted that the pasteurization of milk does not affect its nutritive qualities and vastly improves its bacteriological safety. A small reduction in vitamins B and C occurs as a result of heating, but not to an extent to make any material difference in a mixed diet.

Minimal, Adequate, and Optimal Diets.

These three terms are used to distinguish between a diet that barely prevents frank deficiency disease; a diet that maintains a "passable" degree of health; and a diet that gives buoyant health and abundant vitality.

Much experimentation has been done to determine precisely what constitutes an optimal diet for humans. The experimental animal in nutritional studies is the rat, because the chemistry of its nutrition is very similar to that of humans in nearly all respects except that it does not rely so heavily upon vitamin C. Since the life cycle of the rat is only about one-thirtieth as long as that of humans, many generations can be studied in a short time. Also, they are so small that large numbers of them can be kept and studied in one place at one time.

From laboratory studies it appears that there is a wide variation between the diet that will keep the rat alive and able to reproduce, and the diet that makes it really fit.

In one series of experiments, the rats were fed on three different diets, and were equally exposed to gastro-intestinal infection. The first diet was that of humans in a certain self-respecting community in Scotland; most of the rats died, and not enough survived to continue the experiment. The second diet was the same but with twice as much milk; 60.3% of the rats died of gastro-intestinal infection before the 160th day. The third diet included green vegetables and all the milk the rats wanted to drink; 97.5% of the rats were alive on the 160th day.

In another series of experiments, in India, rats were fed some of the native diets. Those that did not die took on the prevailing physical defects and disease predispositions, and even the temperamental peculiarities, of the humans whose faulty diet they shared.

As was mentioned in Chapter 1, experiments at the Carnegie Institution and elsewhere seem to show quite clearly that an optimal diet lengthens the lifespan in the rat by as much as 10%, and that it particularly extends the period known as the prime of life.

To summarize the findings from various sources, the optimal diet in the case of the rat, and presumably of the human, accom-

plishes these results: (*a*) growth and development to maturity is more rapid and complete; (*b*) a high level of adult vitality is attained; and (*c*) expectation of life at all ages is extended.

An optimal diet varies from an adequate one chiefly in respect to its *protein* content, which may be twice the minimum for life and reproduction; in respect to its *calcium*, which may be three times the minimum; and in respect to *vitamins A* and *B*, which may be four to ten times the minimum.

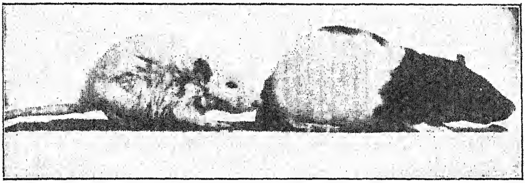


Fig. 100.—Rat fed a diet deficient in vitamin A (left) and rat fed an adequate diet (right). (From McCollum, "The Newer Knowledge of Nutrition." By permission of The Macmillan Company, Publishers.)

Causes of Dietary Deficiencies.

When the diet is not optimal, nor even adequate, it is often because the total intake is too meager in amount, and that the small amount of food that is taken happens not to contain the essentials. This occurs, first, in many of those who lead sedentary lives and have no very great caloric needs; their appetite warns them not to eat too much, but does not warn them not to omit essentials.

Second, it often occurs in those who deliberately reduce the intake to reduce weight. It is possible to reduce the diet to a low level without sacrificing essentials, but most "reducers" pay little attention to that matter (see page 404).

Third, too small an amount of food is often taken by those who take too much alcohol; alcoholics usually suffer from dietary lacks, perhaps even more than from alcoholic excess.

Fourth, deficiencies in diet may result simply from lack of taste for the right foods. It is all too easy to partake of sweets to such an extent that other food has little appeal. For one reason or another, many people are guided too exclusively by taste preferences, and make no effort to cultivate a taste for a food if it does not instantly make a strong gustatory appeal.

In addition, there are those who are not much interested in food of any sort, and simply eat what is handiest; those who have notions that certain foods disagree with them; and those who develop fads based upon advertising of quacks and cultists and of commercial firms.

Finally, perhaps the most important determining factor in a poor diet is lack of knowledge of what is essential. Large numbers of people still have totally wrong ideas about which foods are "strengthening." A bill of fare that would shock a nutritionist would impress many a housewife as exactly the right sort of meal to serve her working husband and her growing children. There are two extremes that are today common. The first has been passed down from a previous generation—the dietary largely of meat, potato and bread. The second is the product of this generation's concentration upon the need for vitamins—the dietary centering around salads and fruit. One is as far wrong as the other.

Intrinsic Causes of Deficiencies.

In some cases, a dietary that would be satisfactory for the nutrition of the normal person in average circumstances, is not satis-

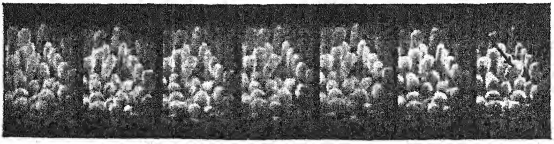


Fig. 101.—Portion of a cinematograph film showing the movements of the villi in the living intestine of the dog. The internal between each frama is approximately one second. Note that the villus indicated by arrow on right becomes gradually shorter, and then longer again in the frame on the left. (Winton and Bayliss "Human Physiology.")

factory for a particular individual in other circumstances—as, for example, in pregnancy. There are many *special conditions* in which one or more of the dietary essentials is needed in extra amounts.

Malnutrition may result even on a generally satisfactory diet if the absorption of foods is poor—of food in general, or of one component of the diet (e.g., iron). Or it may occur if the body lacks the ability to assimilate absorbed nutriment.

If, for any reason whatever, the diet cannot be of the requisite number of calories and as varied as suggested, medical advice should be obtained to make sure that no deficiency is being incurred, and if so, to correct it.

In any special circumstances, such as pregnancy, or during any form of illness, an individual's dietary requirements may change markedly. At such times they are an individual matter, not to be governed by preference certainly, and not even by any nutritional standards for the average individual, but only by professional advice.

Clinical Tests of Nutrition.

The majority of those suffering from dietary deficiency show it in one way or another upon clinical examination. Some of these signs may be evident to laymen, but many of them are not apparent except to the experienced eye of the physician. Others give no visible evidence, but reveal themselves in the course of examination.

Often the individual's symptoms give the clue to the possibility of malnutrition. For example, those suffering from dietary deficiencies often complain of a feeling of weakness, easy fatiguability, nervousness, irritability, lack of appetite, indigestion, constipation, and visual difficulties. Of course all of these symptoms may be due to many other causes, but are frequently present when no other cause exists but faulty diet.

Certain laboratory tests commonly done as a part of a physical examination give evidence whether biochemical processes are proceeding correctly, and often point clearly to a dietary defect. This may be the case with urinalysis and with the customary examination of the blood for hemoglobin and number of red cells. The former gives a considerable amount of information regarding metabolism of protein and of inorganic salts. The latter may indicate a shortage of iron.

When a suspected dietary deficiency is particularly elusive, other specific tests may be done, among them the dark adaptation test for vitamin A deficiency; the galvanic reflex test (a test to measure nerve response to electrical stimulation) for calcium metabolism; and examinations of the blood for ascorbic acid, calcium, phosphatase, and for vitamin A.

Dietetic Study.

Often the most satisfactory way of estimating a dietary deficiency which has not yet given clear-cut clinical evidence is a study of the individual's food habits. This method is often used in the case of those who feel vaguely under-par and in whom no special reason for it can be found. The patient is asked to keep accurate records of the kind and amount of food he takes over a given period of time. In some cases no detailed study is needed, for the first report discloses an obvious inadequacy.

Correcting Dietary Deficiencies.

Ordinarily, dietary deficiencies can be corrected by adding foods to supply the substances that have been lacking. This method is preferable to the taking of vitamin medicines on one's own account, for a diet that is deficient in one substance is likely to be deficient in many, and perhaps in substances that are not yet available as medicines. If an individual cannot take a general diet, then the medicines he needs should be taken at his physician's advice only. The habit of self-prescribing is a bad one, even though the substances taken are good ones.

Hundreds of factors enter into the securing of good nutrition when the body has already become deranged. Simply adding vitamin or mineral pills may not suffice. Many conditions may have to be studied in order to promote the use of food factors in the parts of the body where they are needed. Sometimes furnishing an over-supply either by mouth or by other routes produces the desired nutritive results; sometimes the problem must be approached from other angles.

A National Problem.

There are two ways in which the dietary adequacy of a nation may be learned. The first consists of computing the actual consumption of foodstuffs as compared with the population. It has been shown that sugar is consumed to an extent that would supply every man, woman, and child with 21.8% of their calories. The average per capita consumption of sugar in this country is said to be 115 pounds per year, as contrasted with 10 pounds in 1800. Since sugar furnishes no amino acids, minerals or vitamins, it appears that too much of the national income is spent upon sweets. On the other hand, milk is consumed at the rate of only one pint a day per person. That, however, is an improvement over former times; in 1900, only half as much milk was used. The annual consumption of butter is 17 pounds per person, and of cheese 5 pounds. Both amounts are less than in many other countries, and should be increased. Cheese is an excellent source of protein and calcium; and butter, of vitamin A. In general, the volume of sale of food products indicates that enough money is spent for food, and that nationally we are improving in dietary habits.

A second method of studying national diets is that of obtaining the food records of large numbers of families. Individually, it appears that many families are not properly fed. In the report of the United States in the League of Nations "Survey of National Nutri-

tional Policies," 1937–38, it is stated, "From 40% to 60% of the diets of white families in the four regions from which most extensive data were obtained were found to be in need of improvement."

Commenting upon the cause of poor diets, the report continued, "It is interesting to note that the quality of the food supply selected by families was by no means only a matter of level of food expenditure, for at every expenditure-level above a certain minimum, some families succeeded in obtaining good diets, while others procured only fair or poor from the standpoint of nutritive value. Of every ten white families spending enough or more on food to purchase adequate diets, only from two to four selected good or very good diets."

National Remedies.

Remedies on a national scale for the prevailing faulty diets involve, naturally, educational measures to correct the ignorance that often is the reason why those spending enough money for food fail to get nutritive food. As J. B. S. Haldane has said "Man must use his reason to arrive at an appropriate diet. . . . Humanity is engaged in the awkward passage from an instintive to a rational choice of food."

There are also certain possibilities of changing the quality of the foods themselves. First, there is the possibility of preventing foods from being deprived during their processing of anything nutritive which they contained in the natural state. This is particularly important in the case of foods such as bread that are certain to be consumed in large quantities. The preference for many years has been for finely milled white flour, regardless of the fact that its mineral and vitamin content is lower than that of whole wheat. New methods are being devised to preserve these values and yet to give the people what is wanted in the way of white bread.

Second, there is the possibility of increasing the mineral values of foods by regulating the composition of the soil in which they are grown, and of improving the nutritive values of animal products by attention to the nutrition of live stock.

A third possibility is that of fortifying foods by the addition of vitamins and minerals, either to make up for what has been taken out during processing or to add new values. This has been done in the case of milk; it has been found practical and safe to increase the vitamin D content of milk either by irradiation or by adding the vitamin as such. Also, oleomargarine, a popular low-cost substitute for butter, has been fortified by adding vitamins A and D. As

for minerals, iodine has been added to salt, for use in goitrous regions.

One difficulty in respect to adding vitamins to foods is that unless their use were quite carefully controlled, persons might be led to rely upon a food in which the vitamin was not potent. A difficulty in regard to minerals is that an excess might be as harmful as a deficiency; some minerals would simply be excreted if taken to excess, but others would derange body chemistry.

All of these matters are today being studied in many laboratories, including the National Institute of Health.

A World Problem.

Diet is a problem in all nations of the world, and in many countries a far more serious one than in this country. It is reported that the difficulty throughout the world is not a caloric lack, barring the results of famine due to weather and to war. By and large, the population of the world has enough to eat, but dietaries everywhere lack in almost every necessary constituent except carbohydrate and fat. In other words, the lack in modern diets is usually in the protective foods, rather than in the more strictly energy bearing foods. This is said to be the case with a fourth of the total population of the world.

It is reported that upon the recommendation of the League of Nations, twenty-one countries have formed nutrition committees to find out what foods their people lack and how to supply them. In the words of the committee on the relation of nutrition to health, agriculture and economic policy, "The malnutrition which exists in all countries is at once a challenge and an opportunity." It is called an opportunity because the deficiency diseases are the easiest of all diseases to correct, and correcting them yields the largest results in fitness. The inference to be drawn from the report mentioned was that each nation should consider the good nutrition of its people as an important means of securing economic prosperity, through securing biological prosperity.

Chapter 21

DIGESTION

Good Digestion.

A normally well person who eats sensibly should hardly know, except theoretically, that he has a digestive tract. He should be hungry at mealtimes and not at other times, should have an appetite for most if not all foods, should be able to eat them with enjoyment and without any sort of discomfort thereafter.

If the state of affairs is otherwise, efforts should be made to correct it, for a good digestion is preliminary to good assimilation of nourishment, which in turn is a preliminary to general health and vigor.

From whatever cause digestion falters, it should be given attention at once, for the sake of immediate and remote effects.

Poor Digestion.

"Indigestion" is so common that its symptoms do not need to be mentioned (nausea, "heartburn," eructations of gas or fluid, gaseous distention, pain, rumblings, and vomiting). With it, there is often disorder of elimination, either constipation or diarrhea.

All these symptoms may be due to disease somewhere in the alimentary tract (e.g. gastric ulcer; see page 218) but they may indicate simply poor function on the part of sound organs. *Functional indigestion* is very common. Almost everyone has experienced it at one time or another.

The difficulty in a "digestive upset" may be either with the food that has been eaten or with the person who ate it. Even the strongest stomach will utter protests, and misbehave, if given a too difficult task. On the other hand, it may rebel at even ordinary food, in which case the reason may be that its secretory function or its motor function is "out of order." Either of these functions may be increased, or decreased, or irregular. For one reason or another, the digestive organs may be sensitive, and be irritated by any but the simplest foods.

For whatever reason food fails to digest, if it lingers long undigested in the digestive tract, it is likely to undergo chemical changes. Proteins undergo putrefaction; carbohydrates, fermentation, with

gas formation; fat. decomposition, with the production of irritating substances.

Prevention of Disorder.

To keep a normal digestive tract normal, and to keep it functioning well, involves, first, the consideration of *digestive ability*, as it varies according to general health, and according to hunger and appetite (Sections A and B); and of the *digestibility* of *foods*, according to the kind, the time when taken, and the rate of eating (Sections C, D, and E).

A. DIGESTIVE ABILITY

Generally speaking, digestive power varies according to the general health. To be sure, some invalids seem to have stomachs "made of iron," and some strong people "have to be careful." Nevertheless, far more often the correlation is between good digestion and good health.

Several matters of health, physicians find, are of particular importance in influencing digestive ability. These will be mentioned separately.

Malnutrition.

a. General Malnutrition.—If the body as a whole is malnourished, all its cells are involved, and none of its systems is likely to perform as it should.

The malnourished often have indigestion, and because of indigestion they are likely to become more malnourished. This is a vicious circle, which must be broken into if progressive failure of health is to be avoided. The break may often be made by planning a diet that at one and the same time supplies all nutritive needs and is "easy" on the enfeebled digestive tract.

b. Vitamin B_1 Deficiency.—Indigestion may be solely due to lack of *vitamin* B_1. This vitamin is essential to good nutrition, even to life itself. Also, it is essential to good digestion: it has a specific effect in promoting normal function of the digestive apparatus. Frequently a diet that is satisfactory in total quantity and in most other respects, will supply too little vitamin B_1. Even an individual not malnourished in the wider sense of the term may happen not to take enough vitamin B_1 and in that respect may be malnourished and thereby have poor digestion.

Overfatigue.

Those who would preserve a good digestion or help a halting one must use great discretion in balancing activity and rest. Many

people can digest anything when rested and nothing when fatigued. To be "on the go" too steadily week in and week out may harm any or all organs, but often it is the digestion that suffers first. In such a case, indigestion may be an advantage, if it serves as a warning that the way of life needs changing.

Those who are overfatigued and suffering from indigestion usually eat poorly, thereby becoming more susceptible both to fatigue and to indigestion—another vicious circle, to be broken by rest, with a diet chosen for ease of digestion until such time as overfatigue has been banished.

Illness.

Indigestion may be a manifestation of a pathological condition in the digestive tract or elsewhere. It often occurs, for example, in such varied ailments as appendicitis, anemia, lung tuberculosis, heart trouble, etc. In case of severe indigestion with fever, before attempting to give self-treatment of any sort, it is highly desirable that medical advice be obtained. To delay might even be fatal if the cause of indigestion were an abscess of the appendix. The fact that symptoms may apparently be due to a recognized dietary error immediately preceding does not lessen the need for advice, especially on the part of those at college age, when appendicitis is very prevalent.

In case of persistent indigestion, or recurring attacks, the same is true—it may indicate some sort of illness. Rather than to administer any sort of self-treatment, even by means of changes of diet and habits, medical advice should be obtained for any form of indigestion that seems to be at all chronic.

Sedentary Habits.

Without sufficient exercise, the distribution of the blood to the stomach and all parts of the digestive system is not likely to be satisfactory. To maintain the activity of the circulation, so that it will quickly supply the needs of the functioning organs in all respects, is one of the best ways to ensure the ability to eat and enjoy it. Those who make sports a hobby seldom are the ones who carry little bottles of medicine around with them to dose themselves after meals.

"Nervousness."

As stated in Chapter 12, peptic ulcers are more common in those of intense and emotional nature. Often the more serious condition follows a long period of minor indigestion.

Although it may be a difficult one, the remedy for "nervous indigestion" lies in changing one's nature, or at least in controlling it, by discipline of the emotions.

"Nervous indigestion" may occur even in those of the most balanced personality at times of special stress, but as soon as they can marshal their powers and regain their customary emotional equilibrium, their functions proceed as before.

Medicines and Indigestion.

It is unfortunate that distress in the stomach can often be overcome by taking alkalis (sodium bicarbonate, soda mints, magnesia, etc.), for many victims of indigestion form the habit of eating as they please and then taking medicine for relief. So long as they can rid themselves of discomfort they prefer to ignore the fact that they are not curing but only masking the trouble, and that their errors in diet are meanwhile increasing it. If they abandoned the use of antacid drugs they would soon discover that their dietary habits would have to be changed—but that is what they are not willing to do.

When indigestion is associated with constipation, many people treat it by taking a cathartic or laxative drug—the easiest, but the worst, remedy for constipation (see Chapter 23). In some cases such treatment would be very dangerous (e.g. if the symptoms were due to appendicitis a cathartic might cause the appendix abscess to rupture). In any case, such treatment is no more logical than the use of alkalis, since it merely disguises that which should be cured.

B. HUNGER AND APPETITE

Hunger.

The sensation called hunger is due to rhythmic contraction of the stomach. Usually it indicates that the stomach is empty and ready to receive food. But one may be hungry when not needing food, and one may need food when not hungry. In other words, hunger is not a perfect guide as to the need of eating.

It can readily be noted that hunger often stops as soon as one begins to eat, long before the body cells have received nourishment. Also, water or other non-nutritive substances will stop the sense of hunger for a time. In the laboratory a deflated balloon of thin rubber may be swallowed and then inflated, with the result that hunger stops. Furthermore, hunger may be absent in those who have been without food even to the point of semi-starvation. The hunger-reflex is, however, fairly reliable as a guide to eating in the case of those

whose stomachs are in good order and who eat regularly: they will tend to feel "empty" at the proper times. This is as it should be, for the hunger-reflex is the biological means of assuring nutriment.

When hunger is excessive before mealtimes, and there are "all gone" feelings in the stomach, the cause may be over-fatigue and nervousness, or it may be simply that the previous meal did not "stand by." In general, a meal containing fat postpones the recurrence of hunger longer than a meal that leaves the stomach more quickly (e.g. sugars and starches).

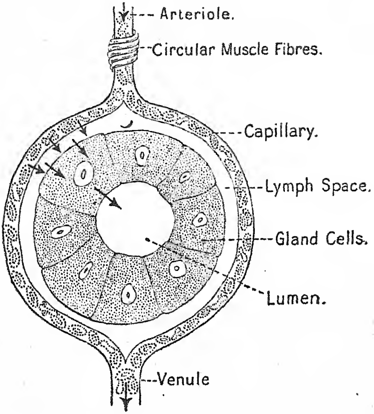


Fig. 102.—Secreting gland. (From Halliburton, "Physiology.")

It is well to investigate hunger that is excessive, especially if accompanied by excessive thirst. Also, absence of hunger should be investigated, especially if appetite is also absent.

Appetite.

Appetite is not the same as hunger. It implies a desire for food for its own sake, not merely to allay pangs of hunger. Often hunger and appetite come together and go together. The hungry person normally has an appetite for any edible food—or at least can eat it rather than go hungry. Yet a person may be hungry and not at all attracted to the available food. Also, a person may not be actually hungry, and yet may eat because of the agreeable taste of food. The

desire for a particular article of food is therefore not a very reliable guide to eating.

A good appetite is a joy to its possessor and also is an aid to his digestive powers. The mere sight or smell of food may make the "mouth water," and this in turn starts the flow of the stomach's digestive juices, so that digestion begins promptly as soon as the food is eaten. This preliminary secretion is sometimes called "appetite juice" to distinguish it from that which comes after food has been eaten.

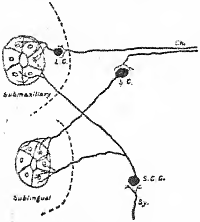


FIG. 103.—Diagram of salivary glands with the secretory nerves that supply them with impulses. Cn, a cerebral nerve; Sy., a sympathetic nerve. L.G., S.G., and S.C.G., nerve ganglia. (From Halliburton, "Physiology.")

Other things being equal, the more appetite juice, the better: hence the habit of preceding the hearty meal of the day by appetizers (hors d'oeuvres, fruit, soup), to which even the most jaded palate is likely to respond. Appetite is also promoted by pleasant surroundings and companions, and by leisure and an agreeable state of mind. Needless to say, the preparation and service of the food itself must be up to the individual's standard, if not of ideal excellence, or it will be likely to banish appetite.

Lack of appetite (anorexia) is often due to lack of vitamin B_1, which is not only a stimulant of digestion, but also of appetite. The addition of foods containing B_1, or the taking of preparations of B_1, will correct a faulty appetite at once if due to that lack. A derangement of appetite may, however, be a symptom of almost any disorder of health, of body or mind.

C. DIGESTIBILITY OF FOODS

A digestible food is one that the digestive tract will easily turn into absorbable nutriment—without working too hard to do so, and without becoming irritated in the process. Most of the foods in common use will be digested—sooner or later, more or less completely, and more or less comfortably—by most people.

To keep a good digestion, it is probably safer to eat a "normal" diet without thinking too much about how foods will affect digestion. Nevertheless, one may well be interested in avoiding abuse of the digestive tract, and still not become abnormally fearful of eating the wrong thing.

With a few exceptions, it is not possible to say that a given food is "digestible" or "indigestible." Much depends upon the amount of it taken at a time, what is eaten with it, how it is prepared, when it is eaten, how it is eaten—and, of course, who eats it. There is also the matter of its purity, for a food that is normally easily digestible will cause disturbance if contaminated by bacteria.

Amount of Food at a Time.

The sense of satiety is as valuable as the sense of hunger. A common cause of indigestion is eating more at a meal than the stomach can handle comfortably. In the case of a baby, or a normal adult who does not usually overeat, the mechanism for emptying the stomach may act to relieve the situation. If not, discomfort may ensue—anything from a feeling of undue fullness to actual pain, due to irritation of the stomach by its overload or by gases that form if the food does not digest. The discomfort may last throughout the entire process of gastric and intestinal digestion, and even may interfere with the latter so as to cause diarrhoea or constipation. Such symptoms may become chronic if the practice of eating too much at a meal continues.

Easily Digested Foods.

To treat the digestive tract especially kindly, the following foods may be used. They will usually not overwork it, nor irritate it.

Milk or malted milk; butter; cream; olive oil.

Eggs; soft-cooked.

Cereals.

Soup; bouillon, cream soup, oyster stew, chowder.

Meat; any tender or well-cooked meat except pork (cooked by any method but frying; well-chewed).

Fish; any white fish (cooked by any method but frying).

Bacon; broiled.

Oysters; cooked by any method but frying.

Vegetables, cooked. Vegetables, raw; lettuce, celery (well-chewed).

Macaroni and spaghetti; boiled or with cream sauce.

Bread; day-old, or crisp toast. Crackers.

Fruit; stewed or canned.

Fruit juice; fresh, or canned.

Puddings; custard, tapioca, jello, rice, junket.

Icecream; plain.

Cake; plain (e.g. sponge, angel).

Cheese; cream.

Common Offenders.

The following foods are, for many people, not easily digestible.

Fried foods.—At high temperatures fats may decompose and become irritating to the digestive tract. Deep frying is better than pan frying, but it requires skill, for the fat must be hot, but not too hot. It is not desirable to eat fried food unless sure of the cook's culinary knowledge and aptitude. Pan frying of meat makes both the meat and the fat less digestible.

"*Rich foods.*"—This term is applied to foods that contain a high percentage of fat. Fat digests more slowly than protein or starches, but usually as completely. However, the presence of much fat in a meal may delay digestion of the whole meal, and in the meantime, discomfort may occur.

Among "rich" foods that may cause trouble are: gravies from which the meat fat has not been removed, and to which starches have been added for thickening; fatty meat, such as pork (except bacon), and fatty fish, such as salmon and mackerel; certain desserts in which fats, starches and sugars are combined, as in pie, plum pudding, etc.

Overdone meat.

Underdone meat, unless the meat is naturally tender. Usually meat requires cooking in order to soften its fibers enough to make it easily digestible.

Cheese (except cottage cheese) if taken in large quantities at a time. When cooked, cheese is less digestible if ropy and leathery.

Dried legumes (beans and peas). Their cellulose covering seems particularly likely to ferment and cause gas, especially when they are baked with fat.

Nuts, unless well chewed, or finely ground, as in peanut butter.

Underdone starchy foods (e.g. underdone griddle cakes, muffins and bread). Further changes take place in starches after they are cooked, which makes day-old bread more digestible than fresh.

Unripe fruits, or any raw fruit not well chewed.

Raw vegetables, unless young, tender and fresh, and well chewed. (Even when cooked, some of the vegetables with coarse cellulose—such as cabbage and onion—need much chewing to make them digestible.)

Highly seasoned or spiced food (the food may digest satisfactorily, but may irritate the mucous membranes).

Very sour food, such as pickles.

Very sweet foods.

Sweets.

Sugars are quickly digested and absorbed, but there is some danger in taking them to excess or in concentrated form, or in the form of foods known as "sweets." This term applies to candy, soda fountain concoctions of icecream with sauces, many desserts, jam, preserves, and marmalade.

Concentrated sweets are irritating to the mucous membranes, because they draw fluid from them when in contact with them (as everyone knows who has observed the puckery feeling in the mouth after sucking a lollypop). For this reason they are likely to cause indigestion if taken on an empty stomach, unless water or other food is taken at the same time.

Also, sweet food may inhibit the appetite for other foods, because their taste is so strong that it makes other foods taste flat and unappetizing; and they give a sense of satiety which may make it seem as if no other food were needed. Finally, when an excess of sugar is taken, it may ferment, with the formation of acids and gas. This is particularly likely to occur if there is delay in digestion, as when sweet foods are taken with, or contain, much fat.

All concentrated sugars (cane, maple, honey, etc.) are alike in producing the effects mentioned, and sweet foods are harmful in the same way (according to their concentration and other factors, as noted). Furthermore, although an excess of sweets is more harmful than a small amount, even very little may cause trouble (e.g. one piece of candy taken into an empty stomach).

Other harmful effects of an excess of sweets have been mentioned elsewhere (e.g. the effect on the weight, the skin, the teeth).

A person who craves sweets should limit his indulgence to the end of a meal. At that time the appetite should be sufficiently appeased to prevent taking an excess, and the stomach will contain enough other food to prevent sweets from irritating. In general, it is desirable to train the appetite to be content with the milder, harmless sweetness of fruits and the simple desserts.

Faulty Combinations.

Of one thing the average person is sure—that certain foods have a "poisonous" effect if eaten together or in the same meal. But unfortunately superstition rather than science is utilized as a guide against harmful combinations. Superstition says, for example, that milk and acid fruit should not be taken together: science says this is entirely harmless. To be sure, acid curdles milk, but milk must be

curdled before it is digested, and, in fact, that is one of the functions of the hydrochloric acid in the stomach secretion. Other superstitions, too numerous to mention, are similarly unfounded.

There are, however, truly faulty combinations of foods, and a knowledge of these should replace popular mistaken notions. A faulty combination consists of two or more foods each of which somewhat taxes digestion and which together may tax it beyond its tolerance. A meal of fried pork chops and gravy, fried potatoes, fresh biscuits, and pie; or of baked beans and pork, brown bread, and doughnuts—these are examples of the way foods should not be combined.

Idiosyncrasies.

This term implies special difficulty in digesting a given food. The explanation may be an allergic reaction, but often it appears to be merely a normal but exaggerated response to a food that most people can eat without difficulty. It is not like allergy in causing symptoms outside the digestive tract.

If one thinks a food disagrees, one should first make certain of the fact before omitting it from the diet. Many people are afraid of a food they think has once upset them, and refuse it in the future without further trial. The disturbance may have been due to some other factor, rather than the food in question, and it may be worth while to try it again. This is especially true of foods that are in common use. To be unnecessarily "finicky" about the diet has both nutritional and social disadvantages.

Beverages.

Fluid may be taken in large quantities with food without interfering with digestion, but usually it is well not to dilate the stomach by taking more than two glasses of water at a meal. That amount of water promotes the appetite and aids digestion to some extent. The same is true of other fluids, especially of fruit juices, and usually of tea and coffee.

Temperature of Food.

A large quantity of ice-cold food or drink taken into the stomach at one time may derange the blood supply of the stomach, act as an irritant to the mucosa and cause spasmodic contraction of muscle fibres, all of which hampers digestion, and perhaps also elimination.

Whatever iced beverages and desserts are taken, they should be taken slowly, so that they will be somewhat warmed in passing through the mouth and oesophagus and not be a thermal shock to

the stomach. If taken at the end of a meal when food is already in the stomach, the effect is less pronounced than when the stomach is empty. Extremely hot foods and beverages are even more harmful. It has frequently been observed that those who develop serious stomach disorders have been addicted to them.

Cooking.

Many foods are cooked, for the following reasons: (*a*) to make them more palatable (e.g. meat); (*b*) to make them also more digestible (e.g. starch); (*c*) to make them also less irritant (e.g. cellulose); (*d*) to make them safe, by destroying parasites and bacteria.

Cooking may, however, not serve any of these purposes unless it is done skillfully. Cooking is an art, and one which everyone should be required to learn before attempting to practice it. Undoubtedly future generations will consider that licensing a person who is to cook is as important as licensing one who is to drive.

Preserved Food.

From the point of view of digestibility, there is no difference between a food that is properly preserved by *canning* or by *cold storage* and the same food in a fresh state.

Food preserved by other methods (e.g. pickled, salted, smoked or dried) may thereby be rendered less readily digestible, but usually not seriously so.

Infected Foods.

When food carries bacteria it is likely to cause a general disturbance of the digestive tract, but especially of the intestines. This is popularly known as "ptomaine poisoning." It is discussed in Chapter 10.

D. MEALS

Regularity.

The habit of eating at regular intervals is one that prevails, and always has prevailed among all races of mankind, and that will prevail among races that survive. There is a reason for this: the digestive tract performs better when it performs regularly. To disrupt its rhythmical cycle is likely to derange it. One of the universal rules of hygiene is to eat at stated times and not at other times.

The precise interval between meals is not so important as their regularity. In this country, the custom is usually three meals a day

about five hours apart, and this interval is satisfactory for most people.

In general, it is better to make breakfast and luncheon regular meals, first, because nutriment is needed during the working hours, and, second, because hunger may cause one to eat at irregular times, or to overeat at dinner.

Extra Meals.

Those who are malnourished or ill sometimes do better on five, or even six, meals a day. To make sure that the digestive tract is not overburdened, extra meals should be of the sort that are easily digested and quickly leave the stomach. For this purpose a meal consisting of milk, milk soup, fruit or fruit juice, and toast or crackers, serves the purpose.

To take extra meals is not to be considered as eating between meals, but as taking "meals between meals"—as regular as the main meals, and, if well chosen, having no harmful effect upon digestion.

Irregular eating of this or that at odd times is to be condemned on the grounds of irregularity and usually also of the character of the food taken.

Social habits sometimes practically force even the well-intentioned to take "refreshments" when they need no refreshing. If such occasions arise, it is a question whether it would be better to eat politely and omit the following meal, or to be impolite and hold to one's meal schedule.

Omitting Meals.

Both digestion and nutrition usually are better served by taking light food rather than none at all when the usual mealtime arrives. Ordinarily it is not desirable to omit a meal except after having overeaten at the previous meal or when abdominal pain or other evidence of disorder of the gastrointestinal tract is present.

Calm at Mealtime.

By giving an animal a meal containing an opaque substance such as barium, and watching the process of digestion by means of a fluoroscope (X-rays), it can be demonstrated that motion of the intestinal tract stops when the animal is irritated or excited (e.g. a cat, by stroking its fur the wrong way, or allowing it to see a dog). The action of the secretory glands is similarly checked (e.g. the dry mouth that accompanies fear is typical of the lessened secretion throughout the digestive tract). In human beings as well as animals

both the flow of digestive juices and the motility of the alimentary muscle fibers are affected by circumstances that arouse mental distress of any sort. For these reasons it is important to eat and to digest in peace.

Perhaps the reason that indigestion "runs in families" is that in some domestic groups mealtimes are utilized for correcting each other's faults, arguing over mooted questions, deciding how to spend the family budget (or worse, how to save it), each person contributing his share to the general atmosphere of trouble. In college groups the misery of each often is made the misery of all, if each feels that he or she cannot miss so good a chance as meals afford for the airing of grievances of one kind or another. One should look upon it as a matter of ethics to let others at least have calm at meals, or, still better, to enable them to enjoy the meals taken in one's company.

As for one's own state of mind, if one is inclined to begin worrying as soon as the mind is not otherwise engaged, the habit should be broken. To do this, one should not simply "try not to worry," but should deliberately make a point of thinking of something pleasant. There are plenty of times during the day when one may work out the answer to difficult problems, but mealtimes are not among them.

Meals and Activities.

Whether one should exercise or do mental work or bathe immediately before or after meals is a question of distribution of the blood. While digesting, the stomach needs much blood, and no activity should be allowed to deprive it of its due supply. Muscular exercise draws much blood to the muscles; mental exercise, to the brain; baths, to the skin. Therefore a suitable interval should intervene between these activities and the taking of food, to permit the necessary circulatory adjustments to be made.

In general, it is desirable not to take baths or start heavy exercise for an hour after meals (several hours, in the case of a Marathon run). Brain work may safely be begun as soon as digestion has started—a few minutes after meals. So also may such minor physical exertion as a stroll.

The reverse is equally true, but to a lesser degree. It is desirable not to eat for fifteen minutes after heavy exercise, nor for five minutes after baths or mental work. A longer interval may be desirable after mental or physical work that has been particularly fatiguing.

E. CHEWING

Need for Mastication.

Digestion starts in the mouth, and that process is subject to considerable voluntary regulation by the aid of mastication or chewing. The purpose of chewing is both mechanical and chemical.

Mechanically, chewing should result in subdividing the food into small particles so that the digestive juices can reach them. Large chunks of food may never be fully digested, and may act as irritants all through the stomach and intestines. If they are finally digested, it will be by means of harder work than the digestive tract should have to do. The food should be in a semi-liquid state when it leaves the stomach, and it is difficult for the stomach to get it into that state unless the mouth and teeth have done their part.

It is apparent that solid food should be chewed, almost, if not quite, until it dissolves. This is one of the universal rules of hygiene.

Chemically, the advantage of chewing is that it stimulates the flow of saliva, and mixes it with the food. Saliva is a digestive juice which acts upon starches, turning them to sugars. If starches are not acted upon in the mouth, they remain starches until they reach the small intestine, for the stomach has no juices to digest them. If starch could move onward promptly to the small intestine, no great harm would be done, but other substances are usually present with them, and these require the usual stay of one to several hours in the stomach. In the meantime, the starches are likely to ferment, causing "gas" and distention.

Furthermore, if protein and starch are present in the same food, the starch dissolves and forms a coating over the bits of protein, and prevents them, too, from being reached by the juices that normally act upon them. Fat digestion is similarly delayed.

In the intestines further difficulties arise. Salivary secretion is the normal stimulus of certain digestive juices there, and indirectly, therefore, failure to chew may impair digestion at all stages. Furthermore, the particles of food that were not digested in the stomach may pass through the entire digestive tract without ever being digested.

The result of too little chewing is likely to be, at the least, an overtaxed digestive system, and perhaps an irritated, even more seriously damaged one.

Americans are notorious as hasty eaters, and also as people prone to digestive disorders. Certainly there is a logical connection between these two facts.

Chapter 22

WATER

The Sense of Thirst.

Thirst, like hunger, represents a "drive" to meet a bodily need. It is one of the self-preservative "instincts." After long lack of fluid, thirst will inevitably indicate what is needed. However, in less extreme conditions, the sense of thirst is less reliable; it is quite possible to be in need of water without being aware of thirst.

The membranes of the mouth and throat are the sense organs of thirst, corresponding to the ear and the eye as the sense organs of hearing and sight. When the whole system lacks sufficient water, the salivary glands do not secrete so much saliva, nor so watery saliva, as usual. The membranes lining the mouth and throat become dry, the sense of thirst is felt, and the impulse arises to moisten these membranes, and thereby to meet the body's need for fluid. Such a need arises either when not enough fluid has been taken in or too much has been given off.

The sensation of thirst may be due to a local rather than a constitutional need for water. Dryness of the membranes of the mouth and throat may come from many causes—for example, from being in hot, dry air; from smoking; from breathing with the mouth open, as during exercise or long speaking or singing, or sleep; from eating dry food that absorbs much saliva, or from eating salty food. Also, in certain emotional conditions such as fear, the mouth may become dry from reflex checking of the flow of saliva.

When not due to a constitutional need, the sense of thirst may be banished merely by taking water or ice into the mouth, or by gum chewing, which increases the flow of saliva.

If the sense of thirst is not present, it does not necessarily mean that water is not needed in the body. For example, the habitual gum chewer might keep the membranes so moist that they would not "register" in the usual manner. Also, a person may become more or less insensitive to a moderate degree of dryness if he habitually keeps these membranes dried as a result of smoking, mouth breathing, or the like. Possibly some people become so much engaged in

their occupation that they scarcely notice the minor discomfort of moderate thirst. For one reason or another, it is believed that the sense of thirst may often not arouse sufficient intake of water.

Occasionally thirst is excessive. The cause may be an unusual local dryness. However, it may indicate an abnormal chemical condition in the body (e.g. diabetes) and should be investigated.

Since thirst is not a sure guide, science will have to be used to find out how much water should be taken daily. The factors to consider are: the amount of water normally present in the body; the amount daily lost; and the amount that must be added to keep the supply replenished.

Amount of Water in the Body.

If a man weighs 150 pounds, about 100 pounds of his weight will be water. There is water in every cell and between all cells. The most highly developed part of the body, the cortex of his brain, is 85% water. It is almost as fluid as the plasma of the blood, which is 90% water. The muscles are from 70–80% water. Most of the tissues except bone would shrink enormously if the water in them were removed.

The fundamental advantage of so much water in the body is that water is the nearest thing to a universal solvent. It will dissolve more materials than any other pure liquid. And, in turn, the advantage of having the materials in the body in solution is that chemical reactions occur much more readily between dissolved materials than between materials in solid form. Life processes, then, depend upon water in cells and in all body fluids.

Moreover, both intake and outgo from the body are made possible because of fluids and moisture. For example, the gases oxygen and carbon dioxide would not pass readily into and out of the body if the lining membranes in the air sacs of the lungs were not moist. Foods could not be readily absorbed from the digestive tract if they were not dissolved in water. Waste materials could not be removed through the kidneys if they were not in solution. The body temperature could not be regulated if it were not for perspiration evaporated upon the surface. The joints would creak, or stick, and all the moving parts of the body be injured by friction between them, if their surfaces were dry.

Constant Loss of Water from the Body.

The daily loss of water in "average" conditions is about as follows: from the lungs, as water vapor in the breath, about 1 pint a day; from the skin, as perspiration, from 1 pint a day to 4 or 5

pints, according to external temperature and bodily activity; from the kidneys, 3 pints.

The total loss by these routes will average for the adult of medium size, activity, and diet, at medium atmospheric temperature, about 3.5 liters per day or more than 3 quarts. If any of the factors mentioned above are more or less than "medium," there will be some variation, which must be taken into account in making up for these daily losses.

Reservoirs.

To meet the constant need for water, to balance the constant loss, water is stored as such in the body, mostly in the loose connective tissues of the muscles and the skin, but also in the cells themselves throughout the body. This is "live storage" not "dead storage" —that is, the water is constantly going into and out from its "garages," or may do so in any emergency. Some animals store more water than man. For example, the camel carries in its hump, among the fat cells, enough water to enable it to survive long desert trips.

People vary somewhat in the amount of free water they retain in the body. When an unusual amount is retained, the difficulty may be in the disproportion between osmosis and filtration, a matter which depends to a considerable extent upon the concentration of the plasma proteins, the health of the kidneys, the blood pressure, etc. Too great retention may also occur when the concentration of salt in the blood is increased, when there is a shift in the acid-base balance, especially an increase in the alkali reserve, in fever, and in certain disorders of the endocrine glands and brain.

Under normal conditions, water is given off from its storage places according to need of water elsewhere in the body.

Adjustments to Lack of Water.

If there is too little total water in the body (either because too little has been taken in or too much has been lost), the first essential is that the blood should have its due supply. The need for water in the blood is of paramount importance. It is absolutely essential that both the fluidity and the volume of the blood be kept normal, or it will not circulate. Therefore, if not enough water is taken in, or too much is lost, the whole system does its best to keep the water-content of the blood normal.

Part of the adjustment is by means of the kidneys. In case of excess, more is excreted by the kidneys; in case of deficiency, some of the water is reabsorbed in the kidneys, allowing less to be given off.

The chief adjustment, however, is made by the tissues and cells throughout most of the body. The moment the blood is threatened with shortage of water, water is given up from the storage places into the blood vessels.

In extreme cases, water leaves not only its usual storage places, but most of the cells of the body. The only organs that do not lose water to keep the blood normal are the brain and the heart.

Water Starvation.

As a result of the measures mentioned above, even a fairly long deprivation of water (3 days in the dog) does not appreciably change the water content of the blood. However, lack of sufficient water will be fatal more quickly than lack of any or all other articles of diet.

To have 10% too little water in the body is a serious matter; to lack 20–22% means death. Humans can do without water as many as 15 days, but since water is essential to the metabolism of food, death occurs much more quickly if food is taken and water not.

Dehydration.

Various degrees of lack of water in the body are not at all uncommon. It occurs in those who neglect the sense of thirst. Also, it occurs in many disordered conditions of the body, especially with fever. For every degree of increase of temperature above normal, there is a loss of approximately 500 cc. of water. Losses also occur whenever vomiting or diarrhoea or bleeding remove fluids from the body.

The results of moderate dehydration are numerous. It causes disturbance in the acid-base balance of the body, usually to the acid side. This is due to an excess of acid products of metabolism (e.g. lactic) and to retention of urinary acids (if the circulation through the kidneys is slowed and less urine excreted). Usually there will be a rise in the nitrogen in the blood. The temperature will rise, because of the reduced volume of circulating blood. The skin will become dried and wrinkled because of loss of fat and water in its deeper layers. Thirst occurs to relieve the situation if fluid is available.

In lesser degrees of dehydration the results may not be at all conspicuous, yet there may be imperfect function of many organs. (The specific value of sufficient water in the digestive processes, in kidney function, and in elimination from the bowels has been mentioned in other chapters.)

Water Intoxication.

Ordinarily, when an excess of water is taken it will be excreted by the kidneys, and the amount of water in the blood and the tissues will remain normal. The danger of taking too much water is therefore of importance only in the case of those not adapted to handling it in the usual way.

Water intoxication occurs especially when urinary secretion is reduced. Experimentally, this may be produced in animals by the administration of pituitrin, one of the extracts of the pituitary gland. It has been suggested that this gland may determine the tendency of some individuals to retain fluid and of others to lose it. Those who

Grams of Water needed for the Complete Metabolism of 100 Kilocalories of some Food Substances

Food Material.	Preformed Water.	Gained by Oxidation.	Lost in Dissipating Heat.	Lost in Excreting End-products.	Deficit of Water.
Protein . .	0	10·3	60	300	350
Starch . . .	0	13·9	60	0	46
Fat . . .	0	11·9	60	0	48
Beef, sirloin . .	25	11·3	60	119	143
Fish, cod . .	120	10·4	60	382	312
Eggs, hen . .	47	11·1	60	154	156
Milk, whole . .	127	12·5	60	123	43
Bread, white. .	14	13·2	60	69	102
Apples, fresh .	150	13·9	60	56	—48

FIG. 104.—A glance at this table shows how carefully water requirements have been computed. (Winton and Bayliss "Human Physiology.")

have any doubt about the state of the heart, the blood vessels or the kidneys would do well to consult a physician regarding the amount of water to be taken daily.

Daily Intake of Water.

For the normal person, the rule is to take enough water daily to make up for the amount of water lost daily. As already mentioned, the amount lost daily will average about 3 quarts, variations occurring according to the amount of urinary excretion and perspiration and according to the diet and the amount of activity.

The necessary 3 quarts of water per day will be obtained from foods, water itself, and other beverages.

A diet of the average sort will furnish perhaps 3½ pints of water. Water is present in even the foods that seem driest, and much is

present in many foods. Even bread is from 25–50% water. (See Fig. 104.) Also, water is formed and turned into the blood as a result of all the oxidative processes in the body.

From other sources than food, $2\frac{1}{2}$ pints of water must usually be obtained daily. The essential 1 pint of milk a day reduces this amount to $1\frac{1}{2}$ pints. This means that from 6 to 8 ordinary drinking glasses of water must be taken as such, or in the form of other water-containing beverages.

Regarding the time of day at which water should be taken, that is a matter of choice. Most people find it convenient to take the daily supply at meals, and perhaps upon rising.

Characteristics of Water for Drinking.

The first essential for drinking water is that it be pure, in the sense of being free from pathogenic bacteria. Most municipal supplies can be relied upon. Private supplies (wells and springs) are not so certain, and if there is not definite knowledge that they are safe, it is better not to drink from them, even though one has been inocculated against typhoid fever. Questionable water can be made safe by boiling, or by the addition of disinfecting solutions. In an emergency, one drop of tincture of iodine added to one quart of water, allowed to stand for half an hour, will render it safe to drink. Ordinarily, bottled beverages put up by reputable manufacturers, and taken from clean containers, are preferable to questionable water.

As for the temperature of water, that is largely a matter of individual choice, except that no beverages should be taken so hot or so cold as to harm the stomach.

Other Beverages.

Any beverage that is mostly water serves the purpose of supplying fluid to the body, but other considerations arise in connection with them.

First, they may contain combustible substances that must be computed in the dietary. This is true of soda fountain drinks and all bottled beverages, of cocoa and chocolate, and of tea and coffee if taken with sugar or cream or both. Also, it is true of fruit juices and lemonade.

Second, they may contain substances that upset digestion. Any of the beverages mentioned may do so in some cases, especially if taken to excess. For the normal person, all of these drinks in moderation are as harmless as they are pleasant. For most people, fruit juices form a valuable means of obtaining vitamin C.

Third, beverages may contain chemicals injurious to health after absorption. The possibilities of harm from beverages containing ethyl alcohol have already been mentioned in Chapter 11. As for tea and coffee, both contain caffein, which is a rather powerful stimulant. They are to some extent habit-forming, in that many persons become somewhat dependent upon them. When coffee and tea do harm it is usually because they are used to cover up the need for rest, and to enable one to keep on working when already overfatigued, or are used as a substitute for food when one is in a hurry. Properly made and not too strong, they appear to do no harm when taken in moderation by those who are well.

Chapter 23

WASTE

All living cells produce waste as a result of their metabolic activity. Some of the wastes are chemicals that have been part of the substance of cells, and some are by-products of biochemical processes of one sort or another. Such materials are no longer of use in the cells that produce them, and would indeed hamper their further activity, or actually poison the cells if they remained present in them. However, normal cells have the ability to excrete their waste into the blood.

Waste materials in the blood are removed from the body by four routes. The lungs automatically remove carbon dioxide. The skin removes a very small amount of dissolved waste in its secretion, perspiration. The kidneys remove by far the largest part of the metabolic waste. The intestines remove chiefly the digestive waste.

It should be noted that waste removal, first from cells and then from the body, is of parallel importance with nutrition. It is just as essential that unnecessary materials be removed as that necessary ones be supplied. The cycle of intake and outgo is constant. Fortunately, the mechanisms for waste removal are almost automatic in the well person. Nevertheless, there are several ways in which conditions may be made favorable for the processes whereby waste is removed.

Since excretion by the lungs and the skin have been considered elsewhere, in this chapter only excretion by the kidneys and elimination by the intestines will be discussed.

A. EXCRETION BY THE KIDNEYS

From the blood that flows through them, the kidneys take some of its water and some of the materials dissolved in it—notably, nitrogeneous waste and mineral salts. The mere removal of water is of importance as a means of regulating water-balance in the body, but the excretion of the dissolved materials is even more important, since some of these are not removed by any other organs, and would have a poisonous effect if they were allowed to accumulate even in

small amounts. This is particularly true of the nitrogenous wastes from the katabolism of protoplasm itself.

The Urine.

In the normal adult, the daily excretion of urine averages about three pints. One of the factors causing variation is the fluid intake. It will be recalled that the normal kidney is able to increase its excretion so as to prevent the body from becoming water-logged when large quantities of water are taken in, and to reduce its output by reabsorption from the tubules so as to conserve fluid in the body when too little is taken in. Also, external temperature influences the amount of urine excreted, chiefly through its effect upon the amount of fluid lost through the skin. In cold weather less sweating occurs and more urine is excreted. In warm weather, the reverse is the case. The amount of urine is also reduced after exercise; while lying down; and as a result of a low-protein diet. During fevers little urine will be excreted unless the water intake is abundant. In various illnesses a change in the volume of urine occurs, and is a symptom to be investigated.

Although urine is constantly being formed, voiding is usually not necessary oftener than four or five times during the day, unless large quantities of fluid are taken, especially tea and coffee, which have the effect of increasing the amount of urine.

The color of the urine is normally amber, but when the amount is increased the color is paler because of dilution, and vice versa. Certain articles of diet, and certain medicines, also cause color changes. Usually the urine is clear.

The following substances are normally dissolved in the urine, in order of amount: urea, sodium chloride, potassium, phosphoric acid, sulphuric acid, creatinine, uric acid, ammonia, hippuric acid, magnesium, calcium, and other substances in lesser amounts. The dissolved materials together weigh about 60 grams in the twenty-four hour quantity. They cause the urine to have a specific gravity of about 1.02.

The Hygiene of the Kidneys.

a. Water.—One of the most important points regarding the hygiene of the kidneys is that of fluid intake. It is essential that enough water be taken to keep the urine diluted to the normal degree. When too little water is taken, less urine is excreted. The amount of water in the urine is decreased, but not the amount of wastes; therefore the urine is more concentrated. Substances that go into solution with difficulty may not be fully excreted unless they are

contained in a large volume of water. And if excreted in concentrated solutions they may be irritating to the kidneys or the bladder, causing them to be susceptible to disease of one sort or another. Also, from a concentrated urine substances may be precipitated, causing the formation of stones. Like gall stones, kidney stones are likely to lead to infection, and may lead to a surgical condition. It is thought that lack of vitamin A in the diet may also be a factor, as well as concentration of the urine, in forming kidney stones.

b. Diet.—If the daily intake of food is chosen to meet all dietary and nutritive needs, it will supply the kidneys with nutriment and will not tax their excretory powers. In spite of popular superstitions, the taking of large quantities of meat appears to do no harm to normal kidneys and in many cases not even to damaged ones. However, the person who has any disorder of the kidneys must usually follow strict rules regarding diet, as prescribed for his personal needs by his physician.

The most important aspect of diet in the prevention of damage to the kidneys is the total amount. The kidneys may well be taxed by having to excrete the end products of too abundant a diet. Furthermore, such a diet is likely to lead to obesity, which in itself is a danger to the kidneys and to the circulatory system.

c. Exposure to Cold.—Chilling of the surface of the body has already been mentioned as one of the causes of an increase in the amount of urine. This phenomenon is normal. But if chilling is marked, the congestion of the kidneys may be excessive and have a serious effect. It is believed that it may often predispose to infection of the kidneys, acute at the time but possibly becoming chronic. This applies to chilling of any part of the body, but perhaps chilling in the region of the kidneys themselves may have still greater importance.

d. Posture.—Poor posture of the body affects the kidneys in some but not all cases. Ordinarily the kidneys are so firmly placed that they are nearly immovable, but in those of the slender type, with little fat around the kidneys, they may sag and become "floating." Often the condition improves with better nutrition. Occasionally in the same type of person, especially those with lordosis (hollow back), the circulation to the kidneys may be impaired so that they become permeable to blood protein, which appears in the urine as albumen. This happens only by day, since the posture is less favorable then than while lying down. Ordinarily it is not a serious ailment, but it suggests the need for the improvement of posture.

e. Exercise.—Normally, exercise is beneficial to the kidneys as to the rest of the body, if taken in suitable amounts. However, after excessive exercise both albumen and sugar may appear in the urine, indicating a temporary functional disability of the kidneys in dealing with nitrogenous and carbohydrate materials. As a transient condition, this ordinarily has no significance, although it is believed that occasionally severe damage may be done to the kidneys by a single "insult" to them in the way of overexertion. It is reported that these urinary findings are seldom encountered in the case of trained Olympic athletes, but are more common in those who do not gauge their exertion according to their training, or do not "train up" to strenuous effort.

Kidney Disease.

One disease of the kidneys—nephritis, or Bright's disease—is so important as a cause of illness and death that it requires special comment, in view of the fact that there are certain measures that may be taken to prevent some forms of the disease.

Nephritis stands fourth among the leading causes of death in this country. In 1937 this disease, in its various forms, was responsible for the death of 106,000 persons in the United States. It cannot be said that all of these were preventable, but undoubtedly a considerable number were.

There are two main types of nephritis, one of which is due to inflammation, and the other to tissue degeneration of circulatory origin. The latter will be mentioned under Arteries, in Chapter 25.

Glomerulonephritis.

This term implies that the chief damage occurs to the glomeruli, the tufts of filtering cells through which the blood passes as it enters the kidneys. The disease occurs chiefly in children and young adults. Most commonly it follows an acute infection—a cold, a sorethroat, an attack of "grippe," a sinus infection or ear infection, or an infection of the skin such as may come from a wound, or from the skin disease impetigo. Often it follows the specific infectious diseases such as scarlet fever or rheumatic fever. Whatever other bacteria cause the illness, it is thought that streptococci are usually involved when nephritis occurs. The kidneys are not infected but are injured by the toxins of the bacteria.

The symptoms of this disease do not begin at the time of the infection, but several days, even as much as three weeks, later. The first symptom is likely to be a slight puffiness of the face, especially of the eyelids. There may be no evidence of abnormality of the urine.

The illness, if detected at that time is likely to be curable. In fact, the fatality in acute nephritis is only about 5%. The serious aspect of acute nephritis is that it tends to become chronic, and to lead to a fatal termination. Most of those who have this type of chronic nephritis do not live to be forty years old.

With the best of treatment during the acute stage, including rest in bed, the outlook for complete recovery may be increased. Without

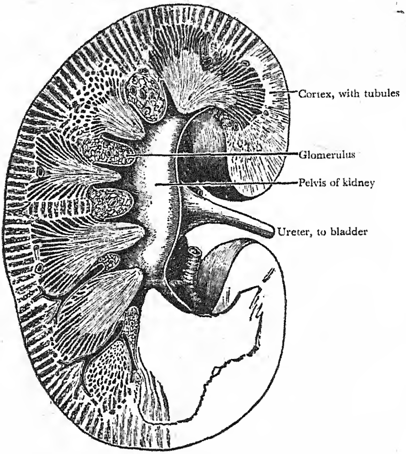


FIG. 105.—Longitudinal section of the kidney. (Bachmann and Bliss.)

such treatment, the condition may progress rapidly, and in severe cases, it may do so regardless of treatment.

Since the illness that precedes nephritis may be very mild, and since its symptoms may be inconspicuous, it is thought that most cases are not seen by physicians during the stage when the progress of the disease might be checked. If the serious results of this type of nephritis are to be prevented, obviously the first symptoms must be recognized more often than is now the case. Any swelling of the face or eyelids, with or without urinary abnormality, should receive medical attention.

A more fundamental step in prevention would be, of course, guarding as fully as possible against any and every sort of infection. Elimination of any chronic focus of infection, especially in the upper respiratory tract (e.g. tonsils, sinuses), is to be recommended.

If acute nephritis is not detected at its onset, it may cure itself, with immunity to further attacks. On the other hand it may progress quietly and give no further symptoms until after much damage has been done, at which time it may be discovered by chance as a result of a routine examination of the urine.

Urinalysis.

Examination of the urine is one of the most enlightening of the diagnostic procedures. It shows, first, how well the kidneys are performing their function. Second, it indicates a great deal about the health of certain other organs, since the chemicals in the urine are the end-products of all cellular activity. Third, it shows to some extent how satisfactory the diet has been, since the chemicals in the urine vary with the diet.

The composition of the urine may vary in many respects. Two of the important tests are for albumen and for sugar. The former may be evidence of kidney disease and the latter of diabetes. However, either may indicate much less serious conditions—in fact, perhaps nothing more than an excess of protein or of carbohydrate in the diet.

Because an examination of the urine may reveal conditions that otherwise would not be suspected, it is recommended that everyone have a urinalysis at least once a year. The periodic examination of the well would be of value for this reason even if it included no more than urinalysis.

Naturally, any apparent abnormality of the urine, such as increased or decreased amount, or change in appearance, should be investigated. So also should any departure from normal in micturition, such as too great frequency, or urgency, or pain. Ordinarily such symptoms have no grave significance. For example, passing urine at night may be merely a bad habit, or be due to drinking too much water in the evening and not enough by day. Yet it is discreet to find out whether any abnormal condition of the bladder or the kidneys is responsible.

Kidney Medicines.

There is a large sale of patent medicines advertised for the treatment of kidney disease. Statements are made to suggest that a pain

in the back, or frequent urination, or pain and burning on urination, or too much or too little urine, or high colored urine, or urination by night, etc. are evidence of "kidney trouble" which the advertised medicine will cure. Pain in the back is seldom a symptom of kidney disease; and the other symptoms are much more likely to be symptoms of trouble in the bladder than in the kidney. The popularity of these medicines continues largely because the amount of water in which they are to be taken relieves bladder irritation. It would be cheaper to take the water without the medicine, and also safer. If symptoms such as those mentioned are present, they may be evidence of conditions that do need scientific treatment, and in any case do need scientific investigation.

B. ELIMINATION BY THE INTESTINES

Intestinal Waste.

The end-products of digestion consist of remnants of food that escaped digestion either because it was indigestible (cellulose) or for some reason was not fully digested, and remnants of bile and digestive juices, with a small amount of iron and calcium. In the excreta there is also a varying amount of water, and many bacteria, one-fifth or more by weight. The bacteria are those normally inhabiting the large intestine, some of which are lactic acid producers and the others of a sort that produce putrefaction of protein residue. In the feces there are usually certain products of bacterial decomposition.

On an average diet, the main bulk of the feces is cellulose from vegetables, grains and fruit. Ordinarily there should be no undigested food—whatever is digestible should digest; nevertheless, particles of food often do pass through the whole tract practically in their original condition.

While in the small intestine, the mass of food is in a semi-liquid condition, but during its stay in the colon water is absorbed, making it semi-solid. Its consistency is partly determined by the diet itself, and partly by the length of time the fecal mass remains in the colon undergoing absorption of water.

Cause of Evacuation.

Motion of the muscle fibers of the alimentary tract causes food to move onward throughout its length. The rate becomes progressively slower, until finally in the colon this motion (peristalsis) is very slow, the material in it being moved along chiefly by the oncoming material from the small intestine.

After a semi-solid cylindroid of fecal material has formed in the terminal part of the colon, the defecation reflex is aroused, and this portion of the contents of the colon may be voluntarily discharged. The reflex may, however, be voluntarily inhibited. Under ordinary conditions the reflex is excited after the taking of food and is responded to once a day, with the passage of a cylindroid approximately six inches in length and one inch in diameter.

Conditions throughout the intestinal tract may make peristalsis more active than usual or less so. In either case, the character of the intestinal contents may be changed, and the rate at which it is evacuated. Also, many conditions affecting the health and many

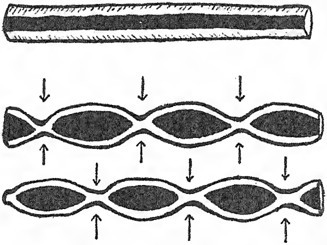


FIG. 106.—The upper figure shoes the intestine at rest. While digesting food its muscle fibers contract, first at one spot and then at another, compressing the mass of food as indicated. Still other sorts of motion take place also.

qualities of food may influence intestinal elimination. The two main disorders will be discussed under the headings diarrhea and constipation.

DIARRHEA

This term means a flow of intestinal waste. The feces are fluid or semi-fluid, because the rate of peristalsis has been too rapid for the usual absorption of water from the colon to take place. Evacuation occurs more frequently, and usually with crampy pain in the colon, called colic.

Diarrhea is usually due to one of the following causes: (*a*) food that is chemically or mechanically irritating, as for example, injudicious combinations of rich food, or food that reaches the intestine in undigested particles, or unripe fruit, etc.; (*b*) bacteria in food, causing intestinal infection such as dysentery, paratyphoid fever, typhoid fever, etc.; (*c*) excitation of the nervous system,

with overstimulation of peristalsis; (*d*) chemicals that may act as irritants or as direct stimulants of peristalsis, of which the most common sort are cathartics. Some of these causes are capable of producing either diarrhea or constipation, or an alternation from one to the other.

Violent intestinal contractions may in some circumstances be physiologically necessary in order to expel an irritant, but if continued, such overactivity of the intestines may cause fatigue of the intestinal musculature, interfere with due absorption of food, abstract too much water from the intestines and the system as a whole, and, most important of all, may change the chemistry of the body adversely by causing undue loss of mineral salts. Furthermore, the cause of the diarrhea may be an ailment or a habit that needs correction. Therefore habitual or recurring attacks of diarrhea, or even a single attack of any severity, should be investigated.

CONSTIPATION

This term may imply: infrequency of evacuation; or a change in the character of the stool, usually with drier consistency; or reduced amount of stool; or difficulty in passage. Often it includes all of these variations from the normal. All are due to delayed progress through the intestines, most commonly in the terminal portion of the colon. Such delay is called stasis (standstill). It is usually relative rather than absolute. The causes of delay lie either in the character of the food or in conditions in the digestive tract as determined by numerous causes.

Two Types of Constipation.

As would be supposed, constipation is often due to weak peristaltic motion, in which case the muscle fibers in the intestinal wall may actually be weak, or may be strong enough but not sufficiently stimulated to activity. When the bowel musculature lacks tone and acts sluggishly it is said to be *atonic*. The difficulty may be exclusively in the intestinal tract, or the musculature throughout the body may be in a similar atonic state. Atonic constipation is common in those whose health is under par. It appears to be particularly common in those who are generally malnourished, although not necessarily thin, and who lead a sedentary life.

A second type of constipation is due to irregular peristaltic motion, with at times strong muscular contractions steadily maintained in one area or another. Such contractions, called spasm, effectively check onward motion as long as they persist. The colon

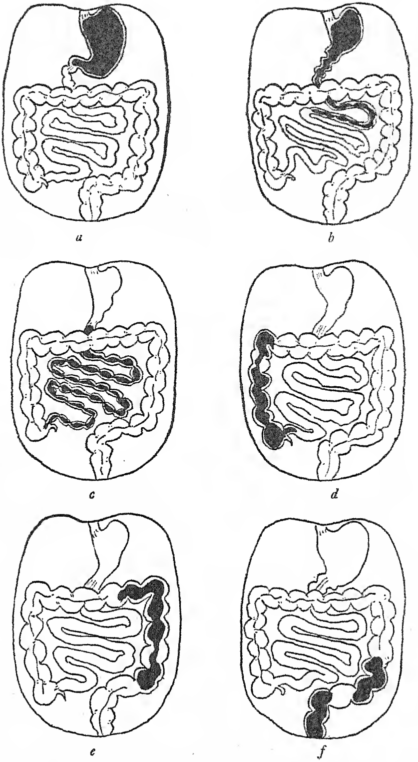


Fig. 107.—The progress of a single meal through the alimentary tract. *a.* stomach filled at 6 P. M. *b.* stomach partly empty at 9 P. M. *c.* stomach empty and small intestines filled at midnight. *d.* large intestine partly filled at 6 A. M. *e.* descending colon filled at noon. *f.* sigmoid and rectum filled at 6 P. M. (Note; variations in the rate of progress occur according to the character of the food and the activity of the tract.)

above the spastic area is likely to relax and balloon with gas or become overfilled with oncoming fecal material. Also, motion in the opposite direction (reverse peristalsis) may occur. Eventually a spasm relaxes, but others may occur in another area. A point at which spasm frequently occurs is the cecum, where the small intestine and the colon unite and where the appendix is attached. It is believed that delay in this area may have a part in causing appendicitis. This type of constipation is called *spastic*.

Results of Constipation.

Delay in the intestinal tract may give rise to symptoms or it may not. If symptoms occur they are likely to include a feeling of distention and local discomfort, with perhaps headache and a feeling of inertia. It appears that a mild degree of reverse peristalsis may be responsible for some of these symptoms. As for absorption of toxins from the colon, there is some reason for believing that that may take place, and be a danger to health. Products of fermentation and putrefaction are present in all colons, but they do not usually pass through the healthy mucous membrane into the circulation. However, if the membrane has become unhealthy as a result of long constipation or other causes, such absorption might occur and cause disordered health. Some authorities are inclined to believe that abosrption of toxins from the colon over a long period of time may be an important factor in causing the degenerative diseases of the heart, blood vessels and kidneys. Many dermatologist believe that constipation is a factor in the disease acne. Virtually all physicians agree that constipation is to be prevented, both for local and general reasons.

Local reasons for preventing overloading of the colon involve the effect of pressure on neighboring structures. A large fecal mass may press upon the veins at the anus, giving hemorrhoids, or "piles." Probably constipation, and the resulting straining at stool, is often the cause of this common ailment.

A mass of retained fecal material may also press upon veins leading to the legs, and contribute to the formation of varicose veins. In some cases harmful pressure may also be exerted upon the veins of the reproductive organs, causing congestion in them. Certain cases of menstrual pain may be definitely related to constipation.

It has already been mentioned elsewhere that bacteria from the colon (colon bacilli) may migrate to the appendix, the gall bladder, or the pancreas, and cause more harm in these locations than they do in their normal habitat, where they are usually non-pathogenic.

Some authorities believe, however, that migration is more likely to occur when the stools are watery than when they are overdry.

Fear of Constipation.

It appears that large numbers of people are suffering as much from the fear of constipation as from the ailment itself. So much has been said in advertisements of cathartics and laxatives that many people feel that they are in danger if the bowels do not move every day and in large amounts.

There is too great readiness to attribute all sorts of symptoms and maladies to constipation. Many symptoms supposedly due to constipation are in reality due to the habits that led to it rather than the ailment itself. For example, lack of exercise may at the same time lead to "poisoned" feelings and to constipation. Those who have chronic intestinal stasis often do not feel or look particularly well, but it is often their whole mode of life that needs attention, rather than the constipation by itself.

Although most normal individuals do have a daily evacuation, a two day interval seems to be normal in some. Even long delay may occur without serious results, as is shown by authentic records of two cases in which no bowel movement occurred for 40 days in one case and 367 days in another.

To be too apprehensive about bowel action creates a state of mind that is especially likely to cause disordered nerve impulses to the intestine and thereby perhaps to induce spasm. Still more important, such apprehension is likely to lead to the cathartic habit, the harm of which will be discussed in a later section.

Only those need fear constipation who are doing nothing scientific to correct it.

REGULATION OF BOWEL ACTION

There are several measures that are of importance in preventing constipation. The same measures will usually be of assistance in curing it when not due to an organic cause.

1. Regular toilet habits.
2. Optimal diet.
3. Enough vitamin B_1.
4. Enough cellulose.
5. Sufficient fluid intake.
6. Regular habits of eating.
7. Correct exercise-rest ratio.
8. Good posture.
9. Emotional poise.
10. No self-prescribed cathartics.

It will be noted that points (3) and (4) are covered by point (2); they are mentioned separately in order to call attention to their specific importance.

In an individual case, some other matter may be of equal importance in correcting constipation or a tendency to it, since almost any disorder of health or faulty habit of living may affect the intestinal tract.

Each of the ten points mentioned will be separately discussed in the following ten sections.

Regular Toilet Habits.

Four points are of importance in connection with the process of evacuation. First, regularity in respect to time of bowel movement should be maintained. The defecation reflex is aroused as a result of the motion that occurs in the stomach after meals, causing peristaltic waves that extend as far as the colon. Evacuation occurs more readily after meals, especially after the first meal of the day. It is recommended that a morning habit be established if possible, but that the impulse should be heeded whenever it occurs.

Second, plenty of time must be allowed, usually as much as five minutes or more. Normal evacuation is seldom as rapid as that produced by cathartics, most of which cause urgency.

Third, voluntary attention must be given to the matter, or the habit of keeping the sphincter contracted will persist at times when it should be relaxed. Attention should not be engaged otherwise.

Fourth, the position of the body should be such as to lend mechanical aid to evacuation—that is, the knees should be at least as high as the hips. If the toilet seat is more than 12 inches from the floor, a footstool may be used to raise the knees.

Optimal Diet.

To give attention to the diet from the point of view of meeting nutritional and digestive needs is of major importance in regulating the bowels. When constipation or a tendency to it exists, the major cause may be that the diet is not well balanced or nutritive, and does not favor any of the physiological functions, including elimination. Or the diet may not be easily digestible, and the undigested particles may cause difficulty all through the tract. Or the total amount of the food eaten may be so small in quantity that it takes a long time for the small residue to move onward. Or the residue may be small because almost all the food eaten was digested and absorbed.

Two components of the diet are of such importance in preventing constipation that they will be discussed in separate sections—vitamin B_1 and cellulose.

Vitamin B_1.

It has long been known that this vitamin has an important effect upon nerves, and also that it is necessary for good digestion. Many physicians believe that a large proportion of constipation is due to the specific lack of this vitamin in the diet. Experimentally, lack of vitamin B_1 has often been shown to be related to abnormal structure and function of the intestinal tract. The mechanism by which it causes constipation appears to be primarily that of lack of tone due to poor responsiveness of the intestinal nerves. Stretching and ballooning of the intestines, with gas formation, is a common result. It has also been reported that fat is deposited in the intestinal walls when vitamin B_1 is deficient in the diet, and that mechanical difficulties result therefrom.

Cellulose.

The large bowel must be provided with a reasonable amount of bulk to stimulate its musculature. It contracts more readily upon a mass of material that fills it to its normal capacity. The natural source of bulk in the diet is the fibrous material (cellulose) in vegetables, fruits, and cereal grains. However, cellulose may be irritating to the mucous membrane and arouse spasm of the musculature unless it has been softened by *cooking* or *chewing*, or both. For many people, the coarser vegetables in the raw state, and also straight bran, prove too irritating. For some, such foods are helpful, but they should not be used except upon medical advice. For the majority, the food residue should be soft and smooth, not rough. Therefore the term *bulkage* is preferable to the commonly used term *roughage*.

In many cases of constipation a bland or smooth diet including the easily digestible foods mentioned on page 363, and excluding those less easily digestible mentioned on page 364, will be of assistance. Such a diet provides sufficient residue without causing irritation.

Fluid Intake.

A certain amount of water must be retained within the contents of the colon to provide bulk and a soft consistency. Whether enough water is retained depends partly upon the length of time the food residue remains in the colon, and partly upon systemic need for water. If there is a shortage of water in the blood, owing to deficient

intake of fluid, or to excessive sweating, or the like, the water in the intestinal contents may be rapidly absorbed. Therefore it is evident that the system must be kept supplied with enough water, or the excreta will inevitably be dried, and usually will be delayed in evacuation. Often an additional glass or two of water a day makes a great difference in preventing a tendency to constipation. In some people, the effects seem to be particularly good if extra water is taken before breakfast. Hot fluids have a tendency to relax spasm, and may, in some cases, be more effective than cold.

Exercise.

Probably constipation is more common in those of sedentary habits than in any others. Often, the addition of half an hour of outdoor exercise a day is very effective in improving bowel habits. Exercise accomplishes its good results in several ways. First, it improves the circulation of blood to the alimentary tract, which favors its healthy functioning. Second, it has a mechanical effect, gently agitating the abdominal viscera and massaging them one against the other. Third, through the effect upon the general health, the musculature as a whole may be improved, and with it the intestinal musculature. Fourth, also through effecting general health, exercise of the right amount may tend to normalize the nerve impulses that govern peristalsis.

In addition to general exercise, it is often desirable that local exercise of the abdominal muscles be taken. If these muscles are relaxed they may fail to hold the organs in their proper position and fail to exert their normal massaging effect upon the intestines. Any sort of exercise that involves bending and twisting at the hips, provided that the abdominal muscles are actually brought into play, will be of advantage in most cases of constipation.

There is a difference of opinion regarding the use of manual massage of the abdomen to promote intestinal evacuation. Certainly if used, it should not be so vigorous as to injure the organs, or to excite reflex spasm.

Regular Habits of Eating.

Many functions of the body are carried on rhythmically, and in every such case disordered rhythm is likely to mean disordered function. This is true of the digestive tract throughout. If digestion in all its phases proceeds rhythmically, the final process of evacuation tends to do so as well. Regardless of the number of meals taken a day, whether the customary three or as many as five or six, they should be taken with a considerable degree of regularity.

Good Posture.

The posture of the body may be such as to cramp the lower chest and limit the motion of the diaphragm, thereby affecting local and general circulation. Also, it is likely to involve stretching and relaxation of abdominal muscles, with unfavorable effects upon the position of the viscera. It appears that poor sitting posture, in which the body slumps forward at the waistline, may be partly responsible for the constipation that occurs so often in the sedentary.

Garments that are unduly constricting about the waist may exert undue pressure upon abdominal organs. A well fitted girdle, not too tight and not extending above the waist, may be an aid to good posture in those whose abdominal muscles are weak. On the other hand, tight elastic bands or belts may hamper free action of the intestines.

Emotional Poise.

Since nerve impulses govern both motion and secretion throughout the digestive tract, it is to be expected that any disturbance of nervous equilibrium would be reflected in gastrointestinal function. What is commonly known as "nervousness" is often the fundamental cause of constipation. The spastic type of constipation is particularly likely to occur in those of "high strung," excitable, or intense disposition, with whom the tempo of life is too rapid. The necessary calm may often be gained by extra sleep. In some cases, however, a change in diet, to one that furnishes all nutritional needs, solves the difficulty with "nerves" and with the disorders resulting therefrom. Of course it is also true that the emotionally unstable usually require better mental hygiene.

No Cathartics.

There is probably no habit of greater antiquity nor more firmly established in the human race than that of taking cathartics. It persists today as a relic of primitive thinking regarding the exorcising of demons causing disease. Castor oil was used in ancient Egypt at the dawn of history for this purpose. Among all peoples, in all times, the superstition remained that the intestinal contents represented a danger, and must be removed. One of the first products of the Gutenberg press was a Purgation Calendar, printed in Mainz, Germany, in 1457. It showed the best days, according to astrology, for the use of purgatives. It was popularly thought in those days, as in times before then and since then, that everyone required such treatment regularly.

In the present century, physicians have made careful studies of the effects of drugs that cause the bowels to move, and have become convinced that they often do harm in one way or another. While they are necessary in some conditions, they should not be used routinely, nor even occasionally, except at the advice of a physician.

The medicines used to cause bowel movement may be classed under two headings—those that act chemically, and those that act mechanically. Those that act chemically produce results in various ways. Some stimulate the nerve-muscle mechanism excessively. After being thus overactive, the intestines may compensate by being underactive for a time, during which period they may become distended with gas. Some have the effect of drawing fluid from the intestinal walls, which liquefies the fecal material but leaves the colon dry. Some irritate the intestine to such an extent as to excite spasm. All tend to create conditions which make normal bowel action more difficult for a few days after each dose.

Medicines that act mechanically include mineral oil which acts as a lubricant, and agar agar, which furnishes bulk. Although their action is milder, it is not desirable to become dependent upon them. Mineral oil if taken regularly may impair nutrition by taking up and carrying away vitamin A, which is soluble in oil. As for substances to furnish bulk, no others than the customary sources of cellulose should be necessary in the case of those who are able to take a normal diet.

Probably most of those who take cathartics actually do not need them. They are misled into thinking that they do because of the popular superstition that there must never be a day without a bowel movement. The habit of taking cathartics may be established after taking a single dose. As a result of that dose, which causes complete evacuation of the colon, leaving it nearly or quite empty, there will be nothing to be evacuated on the following day. On the second day, material will have arrived in the colon, but the fatigued or dried intestine will move it onward slowly, so that no evacuation occurs on that day. In apprehension, the individual then resorts to another catharsis. Many people who are thoroughly convinced that the bowels would never move without a cathartic have never waited long enough to find out what the results would be if the colon were ever allowed to become properly filled.

Others are misled into thinking that they require cathartics because they have a faulty standard regarding the amount that should be evacuated daily. Gauged by the amount eliminated after

taking a cathartic, which empties the entire colon, the normal stool seems insufficient.

Still others are misled by the local discomfort due to the disturbance caused by the cathartic; they interpret it as indicating that the colon again needs emptying.

It is usually safe to stop the cathartic habit abruptly. Those who do so, usually find that the bowels move normally without medicine. This is especially likely to be the case if, at the same time that cathartics are stopped, improved habits such as those mentioned are established.

Chapter 24

WEIGHT

For each person there is probably a weight that for him is optimum—a weight at which he will look and feel and act and be at his best. This individual optimum weight is usually within a range of a few pounds, and a variation outside that range usually does not occur except as a result of illness or disadvantageous habits. Variations from one's optimum weight should arouse interest as to their cause, and also as to their result. Just as they spring from disorder of health or habits, so also do they often lead to further disorder. An individual who varies materially in either direction from his optimum weight is usually incurring health liabilities.

Estimating Optimum Weight.

Tables such as that on page 397 are useful as a starting point in estimating what one should weigh. But two matters must be taken into consideration in comparing one's own weight with the tables. First, the tables give averages of *actual* weights, and actual is not necessarily *optimum*. Among the millions of persons who were weighed and measured to obtain these tables some had good health and some poor. It may logically be assumed that the tables represent average weights of those of "*average*" *health*. Attempts have been made to discover what the average weights are in the case of those in the best of health. From clinical experience it appears that the averages of actual weight correspond rather closely to averages of optimum weight—so closely that the tables are usually considered valid as approximately optimum. However, data from insurance companies shows that the expectation of life is greater in those who weigh somewhat more than the average at ages under 35, and somewhat less than the average after that age. It appears that the individual comparing his weight with the tables should make allowance for this variation according to age.

Second, the average weights represent *average stature*, and the individual who consults the table may vary from the average. Therefore allowance must be made for stature.

Types of Stature.

Two persons of the same sex, height and age may each be at his own optimum weight and yet differ markedly in weight if they

HEIGHT-WEIGHT-AGE AVERAGES

Height		Age 16		Age 17		Age 18		Age 19		Age 20		Age 21		Age 22		Age 23		Age 24		Age 25–29		Age 30–34		Age 35–39		Age 40–44	
Feet	Inches	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
4	10	...	92	...	94	...	96	...	98	...	102	...	105	...	107	...	109	...	111	...	113	...	116	...	119	...	123
4	11	...	95	...	97	...	100	...	103	...	106	...	108	...	110	...	111	...	113	...	115	...	118	...	121	...	125
5	..	101	102	103	104	105	106	107	109	110	111	112	112	114	113	116	114	118	115	122	117	126	120	128	123	131	127
5	1	106	108	108	109	110	111	112	113	115	115	117	116	119	117	121	118	123	119	124	120	127	122	130	125	133	129
5	2	111	113	113	114	116	115	117	116	120	117	121	118	122	119	123	120	124	121	126	122	130	124	132	127	135	133
5	3	115	117	117	118	119	119	121	120	124	121	125	121	126	122	127	123	128	124	129	125	133	127	135	130	138	135
5	4	119	120	120	121	122	122	124	123	127	124	128	125	129	126	130	127	131	128	133	129	136	131	138	134	140	138
5	5	124	123	125	124	126	125	128	126	130	127	131	128	132	129	133	130	135	131	137	132	140	134	142	138	145	142
5	6	128	126	129	127	130	128	132	129	133	130	134	131	135	132	137	133	139	134	141	135	144	138	146	142	149	146
5	7	133	128	134	129	135	130	136	131	137	133	138	134	140	135	141	136	143	138	145	139	148	142	150	146	153	150
5	8	137	132	138	133	139	134	140	135	141	136	142	137	144	138	146	139	147	141	149	143	152	146	155	150	158	154
5	9	141	135	142	136	143	137	144	138	145	139	147	140	148	142	150	144	151	146	153	147	156	150	160	154	163	158
5	10	145	...	146	...	147	...	148	...	149	...	151	...	153	...	155	...	156	...	157	...	161	...	165	...	168	...
5	11	150	...	151	...	152	...	153	...	154	...	156	...	158	...	160	...	161	...	162	...	166	...	170	...	174	...
6	..	155	...	156	...	157	...	158	...	160	...	162	...	164	...	165	...	166	...	167	...	172	...	176	...	180	...

FIG. 108.—Note that this table represents average actual weights. (Adapted, and slightly modified, from tables by Dr. Thomas D. Wood, with his permission.)

belong to different biological types. Those with bulky framework and large, heavy muscles will weigh more at the same height than those of slender bones and light musculature. This is the reason why men usually weigh more than women of the same height, but similar differences in stature exist regardless of sex.

Three definite types of stature prevail among humans. They are: the long-lean, or longilineal, or leptosomic type; the short-stocky, or brevilineal, or round, or pyknic type; and the intermediate or normotypical type. To borrow terms from the era of the horse, they may be called the race horse, dray horse, and carriage horse types. Uncle Sam, as he is portrayed by the cartoonist, is of the long-lean type, and John Bull of the short-stocky type. Individuals of any of these types may be short, tall, or medium in height; it is a matter of skeletal and muscular proportions, whatever the height.

The different types differ in other respects than stature. For example, the intestinal tract is shorter in the longilineal type and longer in the brevilineal, the former corresponding to the carnivorous animals and the latter to the herbiverous. Also, the rate of metabolism tends to be higher in the slim type and lower in the stocky. It is thought that the types tend to differ in temperament (the stocky being the more cheerful and out-going); in susceptibility to a different variety of diseases (the stocky frequently having gall bladder disease, for example, and the slim more often having gastric ulcer); and in longevity (the long lean type being the longer lived, other things being equal).

Departures from Normal Weight.

Whatever the structural build, weight may vary according to the amount of *fat* and the amount of *fluid* in tissues. In most instances when weight is abnormal, the question is predominantly one of fat deposits.

The deposit of fat on the body depends upon the ratio between calories *assimilated* and calories *oxidized*. When weight is stationary (whether normal, high, or low) these two factors exactly balance. But when weight is being either gained or lost, there is a disparity, one way or the other, between assimilation and oxidation.

To account for those who are habitually overweight or underweight, it is necessary to consider the food in reference both to its assimilation and its oxidation. Those who become obese are usually those who assimilate food well. As stated, those of the stocky type may have a long alimentary tract, permitting full absorption of nutriment from the food they take in, and they may have a slow rate

of metabolism, whereby food is burned slowly, some of it not being oxidized but remaining to form fat. Therefore they have a tendency to become and remain too heavy, even though they eat no more than the average and exercise as much as the average. Conversely, those of the slim type may absorb less and oxidize more rapidly, and remain thin on an abundant diet.

When it is not a question of rate, it may be a question of qualitative differences in metabolism, which give some individuals a pronounced tendency to weigh too much or too little. Often these tendencies appear to be hereditary. However, an individual who is overweight or underweight is not usually justified in considering his weight normal for him merely on the grounds that he is like other members of the family; whatever the hereditary tendency, weight usually can be controlled, and should be.

Changing the Weight.

The methods to be mentioned for gaining or losing weight may usually be applied with safety by the individual who is in good health. However, it would be well to obtain medical advice if the weight has remained persistently above or below normal in spite of apparently satisfactory habits of eating and activity; conceivably, other methods than those mentioned might be needed. Also, any spontaneous loss of weight should be investigated, whether in the fat or the thin.

While following a regimen for either gaining or losing weight, changes from day to day have little significance. One should weigh one's self weekly, wearing the same amount of clothing (or none) and at the same time of day with reference to meals and evacuation, so that the conditions from week to week will correspond.

GAINING WEIGHT

Improving Nutrition.

Many of those who are thin are actually malnourished, and need *more* food—more of the same kind they have been taking. Others need *different* food, perhaps with a larger proportion of high-calory foods, or perhaps with a more generous supply of minerals and vitamins. Milk is the best single food for the thin to add to the diet, since it adds nearly all dietary essentials. An extra pint of milk a day, with perhaps crackers or bread with butter or cheese, should cause the average person to gain weight (provided the diet is in other respects satisfactory, other habits are correct, and health is normal).

There are no foods that are "fattening" in the sense that they will inevitably be turned into fat. Each food is potentially fattening to the extent that it increases the total caloric intake beyond the number of calories used.

Many thin persons daily take more calories than they use, and yet remain thin. This may be because they are not "free to gain."

"Free to Gain."

Many of those who are persistently thin in spite of a good diet are not able to utilize food to their advantage; either they do not digest it fully or their cells do not assimilate the absorbed nutriment. Almost any form of *ill health*, such as anemia or chronic infection, may be responsible. So also may *bad habits* such as constant over-fatigue, too much excitement, late hours, and lack of sufficient outdoor air, exercise and sunlight. These obstacles to gaining weight are, of course, of still greater significance in respect to general nutrition and health.

In the case of children it has frequently been shown that additional food does not cause increase of weight until supplemented by additional rest. Rest periods are a regular feature in nutrition classes. For adults, too, a few minutes of rest both before and after meals may be all that is needed to improve nutrition and weight.

Reducing Oxidation.

While increasing the intake of food, it is also logical to reduce its oxidation. In general, those who have been exercising a great deal should reduce the amount of activity, but usually a small amount at least is necessary in order to have a good appetite and good assimilation of food. Those who have been taking very little exercise may, therefore, in some cases profit by increasing the amount.

Medical Treatment.

Often those who are underweight need medicine of one sort or another (e.g. extra supplies of one or more minerals or vitamins; a tonic for the appetite; etc.). With one exception such medicines should be taken only upon prescription. The exception is cod liver oil, an excellent source of vitamins A and D, and a safe and valuable dietary supplement for the malnourished.

REDUCING WEIGHT

The Dangers of Obesity.

Until comparatively recent times, it was thought that if a little fat was good, more was better; those who would now be considered

distinctly fat were considered merely "hale and hearty." A fat young girl was described as "wholesome" in appearance.

It is now known that obesity is a serious defect; if not a disease in itself, it predisposes to a number of diseases. After the age of 35, expectation of life decreases one per cent for every pound over weight. Although obesity is usually considered to begin when the weight is 25% above normal, the dangers of excess weight begin before that level is reached. Several of the handicaps of obesity have been mentioned in other chapters, but they will be listed here.

First, diabetes is very much more prevalent in those who are overweight. The one preventive measure advocated for this disease is keeping the weight normal. Overweight is considered a causative factor. Whether or not there is an accompanying hereditary factor, those who succeed in keeping their weight normal seldom develop diabetes. It is supposed that obesity may lead to diabetes even in those without a hereditary tendency to it, the cause in such cases being the burden placed upon the pancreas when it is called upon to digest an excess of food.

Second, overweight puts a strain upon many other of the vital organs—the heart, the kidneys and the blood vessels in particular. Death from circulatory disorders is two and one-half times as high in the overweight as in the normal. A part of the cause is undoubtedly the heavy coating of fat around the heart, and the fat deposited between the fibers of the heart muscle. The work of the heart thus becomes harder at the same time that its ability becomes less.

Third, liver and gall bladder diseases are especially common in the overweight, partly as a result of the strain they undergo in caring for large amounts of food, and partly because fat is deposited in liver cells.

Fourth, the overweight are likely to suffer from joint troubles due to the mechanical difficulty in carrying their weight. One of the forms of arthritis occurs very largely in the obese, and especially manifests itself in the joints that are subjected to the strain of weight-bearing (the knees, the lower back, and the ankles).

Fifth, surgical operations are often risky in the obese, partly because of the difficulty of access to the abdominal organs through a thick layer of fat in the abdominal wall, and partly because of impaired heart action, deranged metabolic state, and other factors more often unfavorable than in those of normal weight.

Sixth, the obese are particularly affected by high atmospheric temperatures. A large proportion of heat strokes and heat prostra-

tions occur in them, since they do not lose heat readily through their blanket of fat.

Seventh, the obese are susceptible to the dangers of physical overexertion. They are not in a condition to undertake many of the ordinary activities of everyday life without hazard, nor to meet any special needs for extra exertion.

Eighth, not only do the obese suffer directly from the obesity itself, but also indirectly from their inability to take a normal amount of exercise with profit. Although a greater amount of oxidation would help to reduce their weight, after they have once become fat the obese are usually barred from the activity that would help them —barred not only because of their size, but because of their cardiac and other weaknesses. Obviously, this constitutes a vicious circle.

The danger of obesity should be considered as having begun in those who are not yet actually to be classed as obese, but who are slowly and steadily gaining in weight. Young people in the 'teens, especially girls, are likely to weigh a few pounds more than they will in their twenties, and need not, as a rule, be alarmed by this slight degree of overweight, provided it is not increasing from month to month. A tendency to gain should, however, always be taken as a warning.

Basal Metabolic Rate in the Obese.

The explanation of obesity in some of those who eat little is that the rate of metabolism is low. In some cases it is possible to demonstrate such a lowered rate, but more often it is not. However, those who are firmly convinced that they do not eat enough to make them fat should see a physician with a view to having a test of basal metabolism. The physician will consider the possibility of the involvement of the thyroid gland and of other glands of internal secretion that have to do with the metabolic rate (the pituitary and the adrenals), and also of other conditions that affect metabolism and the functional activity of body cells.

If the rate of metabolism is low, it is often possible to bring it up to normal, and thereby to afford assistance in reducing excess weight. If it is not low, efforts to lose weight must center upon regulation of the diet.

Reduced Intake.

If a given amount of energy is used in a day, and the caloric value of the food taken in is less than that amount, the fuel to sustain that amount of energy must come from the body tissues them-

selves. When there is a shortage in the intake of calories, the body tissues are burned, the fat first.

For example, if a person uses energy to the extent of 2400 calories per day, and takes in only 1400 calories, he will be 1000 calories short in his energy supply, and he will of necessity have to burn 1000 calories of his own fat. Since fat yields about 9 calories of heat (or energy) per gram, he will burn 0.285 pounds per day in making up for a food shortage of 1000 calories per day, or about two pounds per week, if his metabolism is normal. He will therefore

THE ENERGY CONTENT OF EXTRA FOODS

Sample tested	*Calories*
Vanilla sweet chocolate, 10 cent cake	629
Milk chocolate, 10 cent cake	220–460
Nut chocolate, 10 cent cake	157–524
Ice cream soda (chocolate, with chocolate ice cream)	443–467
Ice cream soda (fresh strawberry, vanilla ice cream)	436
Plain soda water, chocolate	172–268
Plain soda water, vanilla	239
Soda water with cream, chocolate	357
Sundae, chocolate ice cream, maple walnut sauce	235
Sundae, strawberry ice cream, strawberry sauce and marshmallow	412
Sundae, vanilla ice cream, chocolate sauce, walnuts	396
Sundae, vanilla ice cream, fresh strawberry sauce	334
Ginger ale, 15½ oz. bottle	136

FIG. 109.—(Used by permission of C. G. and F. G. Benedict and the New England Medical and Surgical Journal.)

lose two pounds of weight per week, beginning as soon as metabolism has become adjusted to reduced intake. It may take two to six weeks for loss of weight to begin.

Two pounds is the maximum that should be lost in a week. To reduce the caloric intake so as to create a shortage of 1000 calories and to lose two pounds, the simplest method is that of omitting all sweets and rich foods both at and between meals. Perhaps without realizing it, the average person who is overweight has the habit of taking foods that are not essential for nutritive purposes, but that insidiously increase the total caloric intake beyond his needs. In Fig. 109 are shown the caloric values of some of the foods of which the obese are notoriously fond. Other caloric values are given in Tables I and II in the Appendix.

With no other special attention to the diet, the omission of sweets will often bring about a gradual reduction of weight by a pound or more a week.

In any method of reducing, the total calories must be cut down, but not at the expense of any of the dietary essentials. Also, the total number of calories must not go below the number required to sustain life at the basal level of metabolism. In women this level is often approximately 1425 calories, and in men 1600 calories. Finally, the reduction in calories must not usually create a shortage of more than 1000 calories, or weight will be lost too rapidly.

The list of foods given below comprises about 1425 calories, and provides for nutritive needs at that level. As it stands it would be suitable for the average moderately active girl, using approximately 2425 calories per day, who wished to reduce her weight about two pounds per week. It is too low for men, whose basal requirements are higher. Also, it is too low for girls who use more than 2425 calories per day. By adding the requisite number of calories, it can be adjusted to higher caloric needs and still be used as the basis of a reducing diet.

Amount of Food	*Approximate Number of Calories*
Milk, 2 cups	340
Egg	75
Meat, lean, 1 medium serving (or fish one day a week)	150
Potato, 1 medium	100
Vegetables, leafy; 1 large or 2 small servings daily	30
Vegetables, other juicy kinds: 2 servings (e.g. carrots, broccoli, etc.)	100
Fruit, dried; cooked without sugar (e.g. 4 or 5 prunes)	100
Fruit, fresh (1 apple or 1 orange)	90
Cereal, whole wheat, medium serving, cooked	90
Bread, whole wheat, 2 slices ½″ thick	150
Fat (1 level tablespoonful)	110
Molasses (1 tablespoonful)	55
Codliver oil (1 teaspoonful)	35
	1425

These foods may be distributed among the meals in some such fashion as the following:

Breakfast.

One orange or orange juice
Medium serving of cereal, with milk (¼ cup)
One egg
One slice of bread or toast, with one small pat of butter
Coffee with hot milk, or ½ cup hot milk.

Lunch (or supper).

Vegetable salad, large serving, with very small amount of oil and vinegar
One glass of milk
One slice of bread with one small pat of butter.

Dinner.

Clear soup or bouillon
One medium serving of lean meat, or fish
One medium potato, or mashed potato
One leafy vegetable (lettuce, cabbage, celery, etc.)
Fruit (unsweetened)

Vitamins and Minerals.

It has been shown that the inclusion of a full supply of vitamins and minerals and proteins in the daily diet tends to have a normalizing effect upon weight. Just as these dietary essentials help the person who is under weight to gain, so also do they appear to help the overweight to lose; the explanation is that these substances are essential to normal metabolism, and that obesity as well as malnutrition may represent chemical disorder.

In the diet given above white bread and refined cereals should not be substituted for whole grain products or there will be a shortage of vitamin B. Sugar should not be substituted for molasses or there will be a shortage of iron. Cod liver oil should not be omitted, for it is impossible to obtain enough vitamin D in a low-calory diet without it.

When much weight is to be lost, it is safer to follow a diet individually prescribed for one's own nutritional needs than to follow any diet designed for the average individual.

Hunger.

Hunger is often present at the beginning of a reducing diet, especially in those who have been in the habit of taking large meals which distend the stomach. With smaller meals the stomach may feel painfully empty. However the stomach tends to shrink gradually, to adapt to the smaller rations and in a few days hunger should not be too annoying. Bulky foods of low caloric value, such as lettuce or celery, will tend to allay hunger. Between meals, water tends to allay hunger, but at meals the taking of water or other beverages seems to revive an appetite that might otherwise subside more quickly. Seasonings should not be used to stimulate an appetite already too good. Thorough chewing of food is a successful method of becoming satisfied with a small amount. Also, it will be found more satisfactory to divide the day's rations so as to eat more often. Consommé, which adds virtually no calories, may be taken in the middle of the morning or afternoon.

Increased Oxidation.

Rather than reduce the diet so as to afford fewer calories, one may increase the activity so as to consume more calories. It takes a

great deal of exercise, however, to offset a small amount of food, as shown in Fig. 110. In some cases, exercise increases the rate of metabolism enough to make a given amount of exercise more effective than indicated in this table. In general, the best results in reducing weight are obtained by combining the two methods—taking somewhat more exercise and somewhat less food. This is particularly likely to be true in the case of those who have been comparatively inactive. Those who have long been obese should make sure that they are in condition to profit by exercise before they add to the accustomed amount; it may be better for them to take less exercise when they begin curtailing food. An obese person is often put to bed for the first few weeks of a reducing regimen.

To reduce the weight one pound in one week:	
Add exercise every day for seven days, as below	or Subtract food every day for seven days, as below
Saunter at rate of 2 miles per hour for 8 hours (total, 16 miles)	5 caramels
or	or
Walk fast at rate of 5 miles per hour for 1½ hours (total, 7½ miles)	2 griddle cakes with butter and syrup
or	or
Play billiards 4 hours	4 slices of bread and butter
or	or
Play tennis 1½ hours	2½ doughnuts
or	or
Play football 1 hour (or dig a trench or saw wood 1 hour)	5″ sector of mince pie

Fig. 110.

"Anti-fat Cures."

Vast sums of money are spent annually by those who vainly hope to obtain a sylph-like figure in an easier way than that just outlined; but there is no easier way.

Most reducing medicines do not reduce anything but the pocketbook and the hopes. Nothing applied to the body, or rubbed upon or put into the bath, is of the slightest possible use. For example, of the reducing bath salts are chiefly epsom salts, that tem-ly may draw a little water from the skin, but which have no d no permanent effect. Anti-fat soaps are useful in reducing

weight only to the extent that they remove dirt and a little epidermis. None of these, or any other substances, cause the fat to be "absorbed." Only oxidation will do that.

There is a joker in the directions for the use of many devices, medicines and food products sold for reducing purposes; it is suggested that results may be achieved more rapidly if one abstains from starches and sugars while taking the treatment. In many cases "anti-fat" remedies are not harmful, nor could they conceivably be beneficial except for the dietary restrictions recommended as an adjunct. Countless pills and potions have been analyzed and found to contain no drugs of any potency whatever.

Some reducing medicines are in an entirely different category, and are both potent and dangerous. They reduce weight, but health as well. Among the less dangerous of these are the reducing medicines that contain laxative drugs, to remove food from the alimentary tract before it has had a chance to be absorbed. For obvious reasons this is a most unsafe practice.

The worst of the reducing medicines are those that contain drugs to increase the rate of metabolism. Some contain thyroid gland extract. Even a small amount continuously taken for even a short period might be disastrous for one whose metabolic rate was already rapid enough. The effect would be that of "racing the engine"; while it would use up more fuel, the engine (especially the heart and the nervous system) would be unduly taxed. Whenever thyroid extract is prescribed by a physician for reducing purposes, it is in cases when it meets a physiological need; and even then, the patient is kept under close supervision.

An equally dangerous drug, also contained in certain reducing medicines, is dinitrophenol. The fact that it has the power to increase metabolism was first learned in the case of workers in munition plants, who mysteriously lost weight when using this chemical substance in making explosives. It is not, however, a satisfactory treatment for obesity, since it harms the liver, kidneys, blood, and eyes. Cataract has occurred from its use.

A. J. Cramp, Director of the Bureau of Investigation of the American Medical Association, says "With the possible exception of the credulity of the bald-headed man in the field of hair-growers, there is nowhere to be found such simple trustfulness in the verity of printer's ink as that possessed by the obese woman in the realm of fat cures."

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Chapter 25

THE HEART AND CIRCULATION

To supply all cells with whatever chemicals they need, take away from them whatever waste they produce, and to carry useful substances made in one part of the body to other parts that need them, an active circulation is essential. The term good circulation implies that blood in sufficient quantity flows with sufficient rapidity in and out of all parts of the body constantly, and in increased or decreased amount according to need.

The term poor circulation implies the opposite—slowing of the rate of circulation, with perhaps a faulty distribution not in accord with physiological needs.

Causes of Faulty Circulation.

The major causes of poor circulation are diseases of the *heart* which pumps the blood or of the *arteries* through which it is distributed, and to a less extent of the *veins* through which the blood returns to the heart. Difficulties may also arise as a result of changes in body chemistry which affect the passage of water and salts into and out from the vessels.

In young people 'poor circulation' is often a *functional* matter depending upon rather simple causes. Among these may be mentioned inadequate stimulation of the circulation, owing to *lack of sufficient exercise.* The effect of exercise in stimulating circulation will be more fully discussed in Chapter 29. Also, poor circulation may arise as a result of *faulty posture,* when the chest and the organs in it are cramped and the heart perhaps crowded downward. In such circumstances the pumping power of the heart may be impaired, and, owing to the shallow breathing, the return flow of blood to the heart may be hampered, as mentioned in Chapter 36.

Anemia of Tissues.

The term anemia has two uses. In this connection the term means a relative lack of blood in a part. Its other and more familiar use is mentioned in Chapter 26.

A relative anemia of tissues occurs normally in some circumstances. There is, for example, relatively less blood in the digestive tract when it is not engaged in digesting and while there is more

blood in the muscles as a result of exercise. The principle is that an active part must be especially well supplied with blood, whereas an inactive one needs less. Normally, the blood flows freely to active organs, leaving others temporarily less well supplied. This principle has its application at many points in hygiene, and is frequently referred to elsewhere. For example, it has been mentioned that it is unwise to disturb the normal distribution of blood to the digestive tract by taking a hot bath immediately after a meal, and thereby drawing a large amount of blood to the skin.

Anemia of a part sometimes occurs at times when it is not physiologically helpful. Such symptoms as *dizziness* and *fainting* are often due to faulty distribution of blood to the brain. Dizziness upon getting up from lying down means that the blood either has not promptly left its reservoir in the great abdominal blood vessels to supply the brain with blood, or that the blood in the brain has been drawn by gravity away from it. Fainting is simply a rather pronounced degree of cerebral anemia. It is usually not due to heart disease, but to functionally poor distribution of blood.

Circulatory adjustments are not easily made in all persons. Imperfect adjustment is common in a debilitated state of health; during convalescence; in malnutrition; upon exposure to heat or upon sudden change from heat to cold or from cold to heat; during severe pain; after overexertion; after too long exposure to 'bad air'; after fasting; or from fright. Dizziness or fainting may occur in any of these circumstances. However, a person subject to either of these two symptoms, or any symptoms of faulty distribution of blood, such as numbness or coldness of the extremities, should have them investigated.

Hyperemia of Tissues.

Hyperemia means more blood than usual in a part. A more familiar term for it is congestion. Like anemia, it arises physiologically as a result of need. An *active* hyperemia of the brain occurs, for example, during concentrated brain work. It also occurs in certain abnormal conditions, especially those involving inflammation, as in the pharyngeal membranes during a sore throat.

Passive hyperemia or congestion is due not to the active process of bringing more blood to a part, but to the passive failure of the blood to be moved out of a part. In other words, the blood is dammed back. Parts that are thus passively congested are poorly nourished, because the blood flows too slowly through them. The proper cells of the part do not receive what they need in the way of

nourishment, but the fibrous connective tissue cells (which are able to thrive on less adequate nourishment) may grow in their place. Many diseases are associated with the congestion of passive hyperemia. So also are certain functional disorders—as for example, menstrual pain, which, in some cases, is due to congestion of pelvic circulation.

Edema.

Edema means the undue accumulation of fluid in the spaces between cells. It is likely to occur when the circulation is unduly slow through a part or when chemical conditions are deranged so as to alter the mechanisms of fluid interchange between cells and the blood (e.g. in protein starvation, allergy, etc.).

Although retention of fluid in tissues may occur from other causes, it occurs in many cases of kidney disease and of heart disease, in which case it is known as "dropsy." As was stated in Chapter 23, in nephritis it often appears first in the eyelids. In certain other conditions, it appears in the ankles and legs. Whatever the cause, swelling of any part of the body is in any case not entirely normal, and its cause should be sought.

THE HEART

The effectiveness of the heart as a pump depends upon many factors, of which the most important are the health of its musculature, the adequacy of its valves, and the regularity of its nerve impulses.

Musculature of the Heart.

To maintain circulation in the average adult, the heart must be able to pump the equivalent of ten tons of blood a day. The normal heart will be able to do so easily if it is given proper nourishment, a sufficient amount of rest, and suitable training as a muscle. Relative weakness of the heart may arise if any of these factors are at fault.

Nutrition of the Heart.

The nutritional needs of the heart correspond with those of other tissues. The specific mineral salts and vitamins that are of special value to the heart will be present in adequate amounts in the normal diet. In many cases in which the heart lacks strength, especially during the growing period, the fault is chiefly in the diet. This matter requires attention in any case of heart weakness. Often a correct diet is important as one of the forms of treatment in heart disease.

Rest.

The only real rest that the heart takes during life is between beats. The heart beats are more widely spaced while lying down, and especially while asleep. Lying down saves 10 heart beats a minute. To go to bed at eleven instead of twelve saves 600 heart beats a day. Since each heart beat represents the raising of two pounds one foot, the heart is therefore saved 1200 foot pounds of

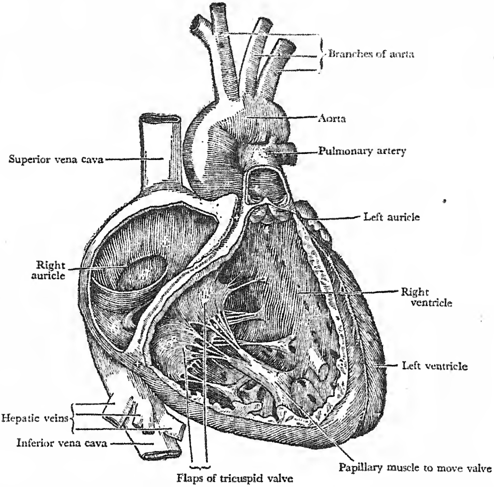


FIG. 111.—Interior of the heart, part of right auricle and ventricle removed to show a valve and the muscles that control its motion. (From Yeo, after Allen Thompson.)

energy per day. In many cases an additional hour of rest provides a much needed opportunity for the heart to build up its strength. The amount of rest the heart needs depends, of course, upon the individual; but whatever the amount, that amount is a genuine need, not to be neglected.

Training the Heart Muscle.

Like all muscles, the heart is subject to training. The normal heart can be trained to contract efficiently and powerfully, or it

can be allowed to remain weak and flabby. In the latter case, the symptoms are scarcely distinguishable from heart disease—lack of "wind," easy fatigue, and poor circulation, with its effects upon all parts of the body. If such symptoms are present, it must be determined that heart disease is not present before any efforts are made to increase the heart's power by increased exercise. To become out of breath easily may be due to being "out of condition" or it may be due to anemia, but it is also one of the first symptoms of heart disease.

Having determined that the heart is normal, one may train it to its full strength by putting gradually increasing demands upon it. Nothing is to be gained, and much may be lost, by embarking upon a too strenuous program of heart training. By keeping well within the limits of heart strain, the limits may be raised, little by little—as every athletic trainer knows.

Heart Strain.

A normal heart has a good deal of reserve power, and can increase its load of work sometimes to extraordinary degree without harm. Precautions about overexertion are advised chiefly for three classes of persons: first, those in whom the heart is still in the developmental stage, which includes children and some young adults in whom full vigor of the heart may not occur for some time after full stature is reached; second, those who have passed the peak of their vigor and in whom the changes characteristic of senility have already begun, although perhaps not evident in any other way except that the circulatory system has lost some of its effectiveness under exertion; and third—perhaps most important of all—those whose hearts are temporarily weakened as a result of illness, especially infection. In such persons, the effect of strain may be a dilatation of the heart and cessation of its beat, although this rarely occurs except in those with heart disease, recognized or not. Less serious results more often occur, yet they may persist and be in varying degree handicapping.

Those who are planning on heavy physical exertion would do well to make sure that the heart is perfectly sound, and then to use it to the extreme only when in good health and free from infection, and when in good training.

Heart Disease.

Heart disease is the commonest cause of death today. It ranks far ahead of cancer, second on the mortality tables. The rate is increasing, although part of the increase is due not to an increase in

the disease but to the fact that more people are now living to the age when heart disease most commonly culminates.

There are two main types of heart disease—that which affects chiefly the valves, and that which involves the heart muscle primarily. The two main causes are infection and faulty blood supply to the heart muscle as a result of arterial disease. Of the infections that cause heart disease, rheumatic fever and syphilis are the two most important. The latter disease was discussed in Chapter 7.

Rheumatic Fever.

As the name implies, rheumatic fever involves inflammation of joints, but this is not the important feature of the disease, for the joints may be only slightly involved, and in any case they entirely recover. The disease is essentially a disease of the heart, for it invariably involves the heart and may leave it permanently damaged. It occurs chiefly in children and young people.

The cause of rheumatic fever is thought to be a streptococcus which gains entrance into the body through the throat. At or before the onset of the disease, inflammation of the tonsils is likely to have been present. In some cases, the disease chorea (popularly known as St. Vitus' dance) is also present, and the nerve symptoms may overshadow the joint symptoms or replace them. Also, scarlet fever may precede the onset of rheumatic heart disease.

Although it is not a notifiable disease, there is some evidence that it may be communicable, at least within families. As with infantile paralysis, however, many individuals appear not to be susceptible to it. But the disease is very common, affecting from 2–4% of the population. It has been estimated that it causes one-third of all deaths from heart disease, and a much higher proportion of those occurring before 40 years of age.

Valvular Defects.

The type of heart disease caused by rheumatic fever is called valvular, because the lesions which cause crippling of the heart are located on the valves. Other infections may similarly injure the heart valves, (e.g. syphilis, gonorrhea, etc.). Also, the heart valves may be affected in non-infectious diseases of heart.

When produced by infection, valvular defects often result from the deposit of bacteria from the blood upon the edges of valves.

There are several possibilities in the case of heart valves thus infected. The infection may be mild and may entirely subside, especially if the individual receives proper treatment and remains absolutely quiet as long as is necessary to give the valves a chance to

heal. Or the infection may be so serious that damage occurs and remains permanent regardless of care. Or the damage may be so great that the individual does not recover from the acute illness.

The most common result is recovery from the first attack of heart infection, with healing of the valves, but without restoration of their

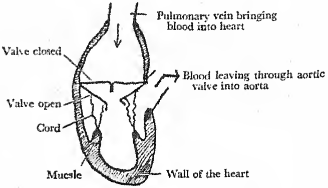


FIG. 112.—Diagram to show the control of the heart valves by muscles attached to cords.

former structure and efficiency. Instead, the valves are deformed so that they either do not open completely or do not close completely. In either case, the regular rate of flow of blood through the heart is hampered.

If a valve does not close completely behind the blood that is pumped out at each beat, some of the blood leaks back, and the valve is called "leaky." If the valve does not open sufficiently wide, the heart is taxed to pump enough blood through it, and may not succeed in doing so. In some cases, a combination of these two valvular deformities (regurgitation and stenosis) occur in the same valve or in different valves in the same heart.

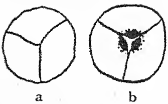


FIG. 113.—(a) Normal heart valves tightly closed; (b) defective heart valves, incompletely closed, permitting backflow.

Similar results may be produced by other conditions that bring about deformity of valves.

(The valves of the heart are well shown in Fig. 34, page 64.)

Compensation.

When a valve "leaks," the heart chamber must pump not only 100% of what it contains, but also the additional 10% or more that leaks back. Having so much more work to do, the heart, under favorable conditions, grows larger and stronger by the process of hypertrophy of its muscle tissue. Because it compensates for a

defect, this increase in size and strength is known as *compensatory hypertrophy*. It does not occur at once after an acute infection, but gradually, over a period of months, or even years—and then only if conditions are made favorable.

After compensation has been established, the heart is able to support circulation well enough to permit the individual to have a more or less normal life. However, a compensated heart may be doing as much work while an individual is sitting still as a normal heart does during heavy exercise. Since it is working at perhaps nearly its maximum under quiet conditions, it has little if any reserve for extra exertion. Therefore, those with sick hearts must choose their occupation and regulate the amount of exercise with care, and must use precautions not to become too fatigued or to lose sleep or to become either malnourished or obese.

Perhaps the greatest danger for those with valvular heart disease is infection, for even a trivial infection may cause further damage to the already damaged valves. Those who have had rheumatic fever appear to be more susceptible to bad effects of throat infections, and should avoid them if possible or have prompt treatment for them if they arise.

On the other hand, it is a mistake for the person with valvular disease to be too apprehensive of trouble. He may live long and well, provided he lives wisely. Many of those with leaky valves live virtually normal lives. Women with good compensation may even retain it during pregnancy and labor.

To prevent a serious outcome, however, it is highly desirable that all persons with valvular heart disease should be under medical supervision, with at least annual examinations.

Myocarditis.

The term myocarditis is applied to inflammation and certain other disease conditions of the myocardium, the muscle of which the heart is composed (*myo*, muscle).

The acute form of myocarditis is due chiefly to bacteria or their toxins. Almost any infection may involve the heart muscle (diphtheria, influenza, scarlet fever, erysipelas, malaria, etc.). The severity varies from slight damage from which complete recovery takes place, to marked, and perhaps fatal, damage. The outcome depends to a considerable extent upon sufficient rest in bed during an infection until the heart action is normal. If specific treatment is available for the disease causing myocarditis, it is likely to have a favorable effect upon the heart condition.

The chronic form of myocarditis may be the continuation of an acute infection, or it may be due to chronic focal infection as in the teeth, tonsils, gall bladder, or elsewhere. Still more often, chronic myocardial disease is a degenerative process due to faulty blood supply to the heart muscle, this in turn being due to disease of its arteries. The muscle fibers of the heart are gradually replaced with non-contractile fibrous tissue. In another common type of myocardial disease, fatty tissue covers the heart and penetrates between muscle cells. This lesion is part of the picture in obesity. As previously stated, overexertion on the part of a person in health appears not to cause disease of the heart muscle.

The term angina pectoris denotes the chest pain and other symptoms often associated with insufficient circulation of blood to the myocardium.

Murmurs.

A murmur is an extra sound in addition to the usual sounds heard while examining the heart through the stethoscope. Although produced at a heart valve, a murmur does not necessarily mean that the valve is diseased. Murmurs may be present in a heart that is perfectly sound. Sometimes they are due to a peculiar way in which the blood eddies through one of the chambers of the heart, especially when the quality of the blood is changed, as in anemia. Although most people do not have murmurs, many have had them at one time or another. A person who has been told that he has a murmur should not feel that he necessarily has heart disease.

Functional Heart Disorder.

For one reason or another, a normal heart may function poorly, and show some of the signs (e.g. murmurs) and symptoms (e.g. shortness of breath) of genuine heart disease. Special tests (e.g. electrocardigraph) may be needed to distinguish the one from the other.

The causes of functional disorder of the heart are not primarily in the heart, but elsewhere in the body. The heart action may be impaired, for example, as a result of malnutrition, anemia, overfatigue and "nervousness." And behind these conditions may lie still other causes—for example, disturbance of the nerves may be due to disorder of the thyroid gland, or to a self-prescribed medicine, or to excessive use of tobacco, etc.

Functional disorders of the heart may, for the time being, require restriction of activity, pending restoration of the heart to normal after the cause of its disorder had been corrected. The outlook is usually good, if a functional disorder has not continued too long.

THE ARTERIES

Normally, the arteries are elastic tubes that adapt readily to the volume of blood that passes through them. Their elasticity enables them to carry blood to and from all parts of body under varying degrees of pressure within them. The health of the arteries is determined by palpating those that lie near the surface; by actually looking at those in the retina that are visible by means of the ophthalmoscope; by measuring the blood pressure by means of the sphygmomanometer; and by various other tests.

Blood Pressure.

The pressure within the arteries depends upon three factors: the force of the heart beat; the resistance of the arterial walls; and the volume of blood in the system. The blood pressure varies somewhat within normal limits, according to age, type of physique, sex, weight, and habits of activity. In a large series of college girls, the average systolic pressure was 115. This means that the pressure during systole or contraction of the heart would raise a column of mercury (in the sphygmomanometer) 115 millimeters. The diastolic pressure (between beats) in this series averaged 80. The difference between these two figures is the pulse pressure. It is thought that 115 is an average systolic pressure in girls and women up to the time when senile changes begin, and that the average for men is about 10 points higher. Few of those who are obese will, however, have blood pressure at these low levels.

Low Blood Pressure.

It is usually not a serious matter if the blood pressure is lower than the figures given as "normal." It may remain consistently lower without interfering with comfort. In such cases, life expectancy appears to be greater, even, than when the pressure is normal.

The individual with low blood pressure (*hypo*tension) may, however, have some of the symptoms of poor circulation—dizziness, cold hands and feet, and a depressed outlook on life—and he may not feel very well. In those who are undernourished and chronically fatigued, low blood pressure appears to be a result rather than a cause. Such individuals may often raise their blood pressure, and at the same time increase their comfort and sense of well-being, by improving their nutrition and taking regular rest periods daily.

Although low blood pressure occurs in many diseases, it is a constant symptom in only one—Addison's disease, involving the

cortex of the adrenal gland. An extract of the gland (cortin) gives excellent results in treatment.

High Blood Pressure.

The blood pressure rises normally during physical exertion and during emotional stress. In some, it remains high constantly—a condition known as *hyper*tension. Although more common after 40 years of age, hypertension may begin in early youth.

As for its causes, sometimes it is a secondary result of disease of the kidneys, in which the flow of blood through them is partly obstructed. In some cases it is secondary to prolonged intense emotions of anxiety and concern over heavy responsibilities in difficult situations. In other cases, no definite cause can be determined, and the disease is called essential hypertension. It is further qualified by the adjective benign if it is not causing symptoms. It is thought that this type of hypertension may possibly be due to imbalance of endocrine glands, some of which have marked effects upon blood pressure.

It will be noted that two forms of hypertension are theoretically at least preventable. According to present knowledge, only one form is curable—that due to emotional stress; and this is curable only if the circumstances and the individual's frame of mind can be brought into harmony.

If a tendency to hypertension exists, or the condition is already established, attention to the mode of life may give good results. With care, the individual with "benign" hypertension may enjoy a nearly normal existence. Such care is necessary because the tendency is for hypertension to injure the artery walls and to damage both the heart and the kidneys. The individual must follow a regimen planned for his personal needs to protect him against straining an already burdened heart and arteries.

Arteriosclerosis.

If a person lives long enough, eventually most of his tissues show the result of wear. Just as the skin in old age becomes dry and inelastic, so do many of the internal tissues, including the important tissues of the artery walls. This gives rise to the condition known as "hardening of the arteries."

The process of arterial degeneration often comes, however, before chronological old age—which led Virchow to say that "a man is as old as his arteries," meaning that whenever the arteries become old, other tissues will necessarily do so also, as a result of poor blood supply.

There appears to be no single cause of arteriosclerosis occurring before old age. Hypertension inevitably leads to it sooner or later, but few other specific causes have been discovered. It is known that the disease may occur and progress rapidly after certain acute infections, and this has led to the suspicion that perhaps low grade infections such as may exist in chronic foci may often be the cause.

Also, it is known that arteriosclerosis may result from chronic lead poisoning. This has aroused the suspicion that other chronic chemical poisonings might bring about the same result. With the

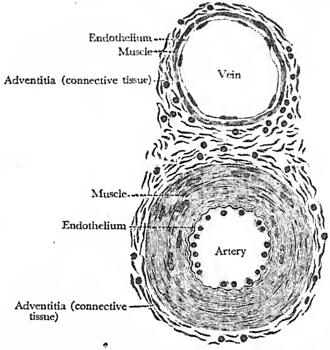


FIG. 114.—Transverse section through a small artery and vein. (From Halliburton, "Physiology.")

possible exception of tobacco, no other chemicals have as yet been implicated, however.

Various metabolic disturbances, such as those associated with gout, diabetes and Bright's disease, often lead to arteriosclerosis. In fact, many believe that the disease is essentially a metabolic disorder.

It seems logical to suppose that the arteries are subject to injury from many different causes. Whether or not an hereditary susceptibility exists, the measure suggested for the prevention of arteriosclerosis is an inclusive one—protection against any and all conditions capable of injuring tissue. Such conditions include, of course, infections and poisons, but they also include faulty modes of life, especially excesses in diet or in muscular exertion or in emotion.

Whatever may start the process of degeneration of arteries, the outcome is likely to be serious, especially in those who do not live

wisely. The arteries to the heart muscle (coronary arteries), for example, may fail to provide it with adequate nourishment, and coronary disease occur. This is a rapidly increasing cause of death among active men in business and professional life. Or the blood vessels to the brain may fail to nourish it, causing mental symptoms or frank mental disease. Or the arteries to the kidneys may be involved, causing nephritis.

It is, however, true, that many people live to a ripe old age with arteriosclerosis that has been present for years. Probably a good many more could do so if they could, or would, adjust their habits and situation to the limitations of their circulatory system.

Cardio-vascular-renal Disease.

In many cases, the first time that a person consults a physician—for example, for shortness of breath or headache or edema—he already has a complex of conditions which is known as cardio-vascular-renal disease because it involves heart, blood vessels (with hypertension) and kidneys. It cannot often be determined just where the condition began, for each of these conditions aggravates the other—a "vicious circle." Although such a condition is incurable, its progress may often be delayed by wise management. Much may often be done to favor the embarrassed organs. The final outcome depends upon the support or relief that may be given them. Naturally, the earlier the condition is discovered, the greater the likelihood of keeping it in control.

Syphilitic Disease of the Arteries.

A condition somewhat resembling arteriosclerosis may be one of the manifestations of syphilis. It is particularly likely to involve the main artery leading from the heart, the aorta. The walls of this vessel weaken and stretch, even to the point of rupture. After syphilis has involved the heart or the arteries the damage cannot be repaired, but it can be prevented by early and thorough treatment of the disease.

THE VEINS

The chief difficulty in the case of the veins is due to the fact that the return circulation of the blood through the veins from the lower part of the body to the heart must be accomplished against gravity. The two forces that make this possible are the pressure exerted by the oncoming blood from the heart and the pressure exerted on the walls of veins by the contraction of muscles against which they lie. In many veins there are valves which prevent the blood from flowing backward.

Difficulties may arise in veins that have no valves, or in veins in which the valves have been destroyed. The cause of trouble in either case is too much pressure of blood within the veins, created by pressure from above. When veins are overfull they tend to dilate and even to lengthen and become tortuous—a condition known as varicose veins. Special names are applied to varicose veins in certain areas (e.g. varicocele, in the veins of the scrotum; hemorrhoids or "piles" in the veins of the rectum or the anus).

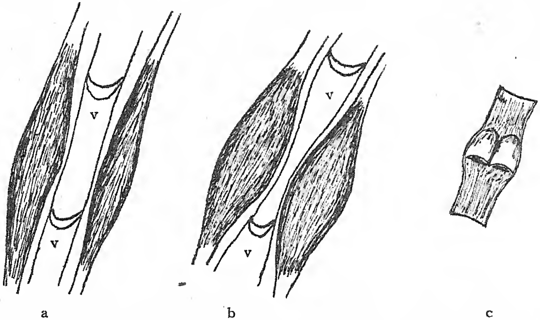


FIG. 115.—Diagram of a vein between two muscles; (a) muscles relaxed, (b) muscles contracted and pressing upon vein; (c) vein opened, to show cup-like valves.

Varicose Veins of the Legs.

There are two sets of veins in the legs, a deep set situated among the muscles near to the bones, and a superficial set just beneath the skin. They communicate with each other. Both are well supplied with valves. As long as the valves remain competent, these veins do not become varicose.

However, the valves in the superficial set often become weakened or entirely destroyed in circumstances that temporarily throw a great load upon them. For example, if the pressure in the veins within the abdomen is greatly increased, it may exert enough back pressure on the leg veins to obliterate the valves. Back pressure of such a degree may occur as a result of heavy lifting, or, in the case of women, as a result of pregnancy. Occasionally varicose veins occur in those whose occupation requires long standing with little opportunity for the muscle exercise that would help to counteract the effect of gravity.

In either sex, the veins may be hereditarily subject to varix, and may dilate in response to moderate degrees of pressure, such as

constipation. A tendency to varicose veins may be suspected when veins are conspicuous and slightly dilated. In such case, tight garters should not be worn around the legs, nor should the knees be crossed one over the other.

After varicose veins have developed they may be treated by surgical removal. The surface veins bear the brunt of the harm, since they are not surrounded by muscles to keep them from dilating, and usually the deep veins remain normal and will care for circulation properly after the superficial veins have been removed. Another form of treatment is injection of chemicals to obliterate the veins. In some cases, relief of symptoms may be obtained by wearing a snug fitting elastic stocking at all times except when lying down, and by keeping the legs horizontal whenever convenient.

Hemorrhoids.

The veins in the rectum and anus have no valves, and may readily become dilated as a result of constipation and straining at stool. External hemorrhoids appear as small tabs of membrane, often causing no symptoms, or merely slight irritation. Internal hemorrhoids may not be suspected except for the fact that they occasionally bleed slightly. Often the correction of constipation relieves them, although they may require local treatment. Any bleeding or soreness in this region should receive medical attention.

Varicocele.

If slight in degree, this condition may require no treatment. When needed, treatment consists of the use of a suspensory bandage, which must be well fitted if it is not to do more harm than good; or surgical removal of the varicose vein. Ordinarily the condition does not in any way affect the generative function.

Phlebitis.

Like all tissues of the body, the veins are subject to infection. Phlebitis (infection of veins) is perhaps more likely to occur in veins that are varicose. As is the case with all injuries to the walls of vessels, arteries or veins, one of the dangers is that a clot (thrombus) will form and perhaps circulate to an important organ and shut off its blood supply, with serious or possibly fatal results. Bed rest is always required until the danger of loosening a clot has passed.

Because phlebitis is more common in the legs following pregnancy, during the period of lactation, it is popularly known as "milk leg." It often occurs in other circumstances however, both in males and females.

Chapter 26

THE BLOOD

Volume.

The body of a man weighing 150 pounds contains about six quarts of blood, or approximately 8% of his body weight.

The volume of the blood remains practically constant by means of adjustments made between excretion of fluid by the kidneys to keep blood volume from rising, and withdrawal of blood from tissues to keep it from falling. These automatic adjustments of blood volume are normally aided through the sense of thirst which more or less clearly indicates the need of the blood and tissues for water.

After hemorrhage (bleeding) the two mechanisms mentioned normally restore blood volume gradually, so that no harm results except when a large amount of blood is suddenly lost. It is possible to lose a pint of blood at a time and feel and be none the worse for it. But a sudden loss of two quarts would be fatal.

In health emergencies, the volume of blood must sometimes be increased by transfusion of blood from another, or of salt solution. Much more rarely, the volume must be reduced by "blood letting."

The blood is composed of a fluid called plasma, in which float three kinds of cells or corpuscles—red cells, white cells, and platelets.

The Plasma.

The plasma of the blood is 90% water, with many chemical substances suspended or dissolved in it. Everything that the body cells receive, use, or give off is at one time or another in the blood plasma. It regularly carries (*a*) foodstuffs and water to the tissues; (*b*) waste products from them to the excretory organs; (*c*) various enzymes and hormones in transit from their place of manufacture to the place where they are to be used; and (*d*) the chemicals that keep the composition of the blood itself in its normal state and that govern the exchange of chemicals between blood and cells. It has been mentioned, in the chapters on foods and the diet, that the percentage of several of the inorganic salts in the blood plasma (sodium, calcium, potassium and phosphorus) is of vital importance.

The same is also true of glucose and the plasma proteins. The chemistry of the blood is extraordinarily complex. A correct composition of the blood is largely determined by correct intake of food, and, of course, by the health of all the organs.

In most people, the blood also carries antibodies against certain infections—these varying with the individual. It does not normally contain bacteria, although during infections the plasma contains toxins of bacteria or even bacteria themselves.

Composition of Normal Human Blood

	Concentration in	
	Plasma. g./100 c.c.	Corpuscles. g./100 c.c.
Water	90	65
Sodium	0·345	0·042
Potassium	0·020	0·425
Calcium	0·009	0·003
Chloride	0·380	0·185
Bicarbonate	0·168	0·090
Phosphate (inorganic)	0·015	0·016
Sulphate (inorganic)	0·002	0·002
Lactate normal	0·02	0·012
Lactate maximum	0·2	0·12
Protein	8	30
Total fats	0·65	—
Fatty acids (as soaps)	0·05	—
Lecithin	0·2	0·4
Cholesterol	0·15	0·15
Urea	0·03	0·03
Glucose	0·1	0·08

Total molecular concentration 160 millimols per litre.
≡ 0·95 per cent. NaCl

	c.c./100 c.c.	c.c./100 c.c.
Carbon dioxide arterial dissolved	2·55	1·90
Carbon dioxide arterial combined	60	29·5
Carbon dioxide venous dissolved	3·15	2·25
Carbon dioxide venous combined	64·5	36·5
Oxygen arterial	0·3	47
Oxygen venous	0·1	26·5
Nitrogen	1·0	0·9

Fig. 116.

(From Winton and Bayliss "Human Physiology" The Blakiston Company.)

Chemical Tests of the Blood.

Although the blood comes into functional contact with all tissues and takes up material from them, the chemical composition of the plasma is normally nearly constant; variations therefore have significance. The study of blood chemistry is essential in the diagnosis and treatment of metabolic diseases. For example, in diabetes it is necessary to know the percentage of sugar and of other chemicals; and in nephritis, the percentage of nitrogen compounds. In many other abnormal conditions a great deal can be learned about what is going on in the various tissues and organs by the study of the chemistry of the blood. Also, the blood is often examined for the evidence it affords regarding the diet.

In infection, or suspected infection, the blood is examined for bacteria or their products, or for substances produced in reaction to bacteria (e.g., immune bodies). Among the commonly used tests of the blood serum are the Wassermann and the Kahn tests for syphilis and the Widal test for typhoid fever.

For some of the tests of the blood, only a small quantity is necessary, which may be obtained by pricking the lobe of the ear or the finger; for other tests, a somewhat larger amount is required, and this is obtained from a vein.

Acid-base Balance of the Blood.

Acidosis is a term which means acidity; actually it refers to a relative decrease of alkalinity, not an absolute acidity. Carbon dioxide, lactic acid, and other metabolic acids are regularly produced in the body, and as regularly destroyed or neutralised or removed from the body by the lungs or the kidneys. A very precise mechanism exists for keeping the reaction of the blood at its normal degree of slightly alkalinity.

In health, a temporary acidosis occurs after severe exercise. Certain abnormal conditions may also cause an increase of acidity —for example, it may occur if too little fluid is taken or too much is lost, as in diarrheal diseases; and in starvation or near-starvation, as when extremely low calory diets are taken. It is a common complication in diabetes.

Alkalosis is not common except at high altitudes, when carbon dioxide production is low in proportion to the amount of air that is breathed. It may occur, however, as a result of excessive intake of alkalis, and in certain abnormal states.

Foods have an alkali-producing or an acid-producing effect, but in health no ordinary diet changes the reaction of the blood. It is

chiefly in disease of the kidneys that attention must be given to this aspect of diet.

The term "an acid condition" as popularly used to account for almost any form of ill health, is meaningless.

Transfusion.

In certain circumstances life may be saved by the transfusion of blood from a well person to one who is ill. Transfusion is done for the replacement of blood lost by hemorrhage, or of blood destroyed by an infection that dissolves red blood cells. Also, it is done in case of shock, when the volume of the blood and the blood pressure are low and heart output reduced. In less dramatic circumstances transfusions are often valuable—for example, in certain blood diseases, and in a number of conditions prior to surgical operations.

When needed, no other form of treatment serves as well, because it supplies all the elements of the blood, but in the absence of blood for transfusion, a solution of sodium chloride (common salt) in proportions comparable to that of the blood may temporarily serve the purpose when the need is for increased blood volume only.

Transfusions are often given in. infections for the purpose of supplying immune substances. The blood in such a case is obtained from a person who has recovered recently, or even a long time before, from the same infection. In some cases, transfusions are of service even from those who are not known to have had the infection.

The blood used for transfusions is often obtained from a member of the patient's family. But all hospitals have lists of donors—young men in good health who can spare the requisite amount of blood and are willing to sell it. The usual amount used is about a pint, for which the donor may receive from thirty-five to fifty dollars. The lives of donors are carefully supervised and regulated, so that they shall be free of any infection that could be transmitted in their blood.

The idea of establishing headquarters for stored blood originated with physicians in the United States Army, in 1918, on the basis of work done at the Rockefeller Institute for Medical Research, which showed that blood properly preserved is useful for as many as ten days after it is drawn. Blood banks, as they are called, are now maintained in many cities. A plentiful supply of blood may be obtained from the blood-carrying organ the placenta which is delivered from the uterus at the time of childbirth.

Blood Groups.

Although transfusion had been attempted in past centuries, the results were often disastrous, owing to lack of knowledge regarding differences in blood. In 1900, Landsteiner, who later received the Nobel prize, made the discovery that human blood belongs to four different groups and that only the same group may safely be used in transfusion. The serum of blood from one group will cause the red cells of another group to come together in clumps and then to dissolve.

When blood from one person is to be transfused into another, each blood must be typed, i.e., its group be determined by laboratory tests. It is reported that some of the soldiers in Europe are having their blood group classification tatooed on their arms so that there need be no delay and no mistake should they require transfusion.

There were originally two different classifications of blood, each using the numbers I–IV, but the groups not corresponding. To do away with the confusion, a third classification, the International, is now in use, in which the groups bear letters—*O*, *A*, *B*, and *AB*. Approximately 10% have blood of group *O*; 40%, *A*; 7%, *B*; and 43%, *AB*. The group is determined by heredity, a fact that is sometimes of medico-legal use, as in determining paternity. Haldane has suggested that the four blood groups indicate the four different points of origin of the human race. It has been possible to type the blood of mummies thousands of years old.

White Blood Cells.

It was less than seventy years ago that Ehrlich first introduced the method of drying and staining thin films of blood so that the blood cells could be studied. In 1877 he first classified the various forms of white cells, or leucocytes. They are called *granulocytes*, of which there are three varieties normally present in the blood; *lymphocytes*, large and small; and *monocytes*.

As seen in the blood, the white cells are always on their way from the bone marrow, lymphoid tissue or spleen to an area where they are to perform their functions. The total number in the blood of a normal person in health is not far from 7,000 per cubic millimeter. They are constantly being worn out and replaced.

The phagocytic function of the white blood cells was mentioned in reference to resistance to infection. The term phagocyte, which means devourer, was first given to certain white blood cells by

Metchnikoff, when he observed that they surround and destroy bacteria and certain other potentially harmful foreign substances that have entered the body. Some of them are phagocytic in the blood stream and others at the point of localization of infection, to which they are "attracted." Presumably the attraction is a chemical one, but there is no satisfactory explanation of the remarkable power

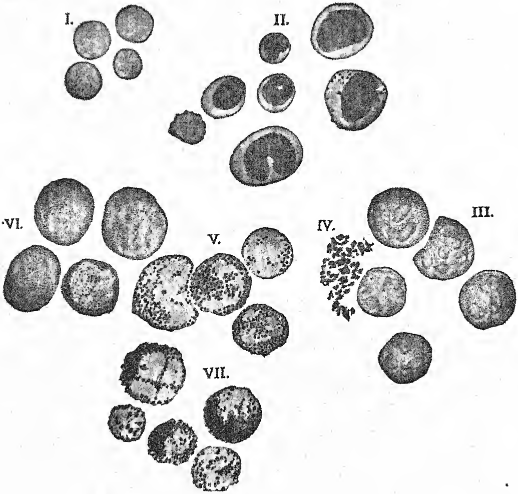


FIG. 117.—Blood corpuscles. I, red corpuscles: IV, platelets: II, III, V, VI, VII, various white corpuscles. (Bachmann and Bliss.)

of the leucocytes to change their shape, migrate through blood vessel walls, and arrive at precisely the area where their services are most useful.

White-cell Count.

The total number of white cells in the blood and the relative proportions of the different kinds does not ordinarily vary to any great extent except in response to infection. To count the number of cells in a small amount of blood and thereby to estimate the total number in the blood is therefore a test of great value. The white cell

count is made by means of a counting chamber in which is placed a thin film of diluted blood treated so as to dissolve red cells. Under the microscope the number of white cells in the marked-off divisions are counted and the number is multiplied by the dilution.

An increased number of white cells (more than 10,000) is known as a "high white count" or *leucocytosis*. It occurs in response to most infections but not all; in some infections the number of white cells remains the same or is decreased.

When infection is present but not clearly apparent, a white count will aid in making the diagnosis. Also, the level of the white count will generally indicate the severity of the infection; the more severe the infection the higher the leucocytosis, except in very grave infection in which the body is failing in its resistance and the count either remains low or falls after having been high. During infection, the white cells are often counted frequently, in order to gauge the progress of the infection; in general, the count gradually falls as recovery takes place.

The counting of the different types of white cells, a "differential count," gives still further information, for in some conditions one sort will be increased in proportion to others, or white cells not yet mature appear in the blood.

A low white cell count, below 5,000, is called *leucopenia*. It occurs in certain infections, such as typhoid fever, and also in certain poisonings, and in some diseases of the blood-making organs.

Disorders of White Cells.

Leucemia is a disease of the bone marrow in which it becomes excessively active in producing white cells. The white count may rise into the hundred thousands, far higher than leucocytosis in response to infection.

Another disease giving a high white count is known as *infectious mononucleosis* (an increase of monocytes, due to infection). It is an epidemic disease occurring chiefly in the young. The lymph nodes enlarge at the time, but usually they eventually return to normal size.

In recent years, there has been an increased number of cases of a disease called *agranulocytosis* (a deficiency of granulocytes). It occurs in benzol poisoning. Also a number of cases have occurred in those who have taken medicines containing a benzol derivative called amidopyrine. This drug is an ingredient of many proprietary medicines for fever, headache, insomnia, menstrual pain, et cetera. It is believed that certain other drugs predispose to the disease.

Cases have been reported following the self-prescribed use of sulfapyridine. The outlook for recovery is poor.

Red Blood Cells.

The red blood cells, or erythrocytes, exist in huge numbers in the blood—approximately 30,000,000,000,000. End to end, someone has computed, they would form a chain extending five times around the earth at the equator. If spread out flat on a field, they would cover one acre. On the head of a pin 60,000 could be placed. They are constantly coming to the end of their lifespan, which is thought to be from one to three months; apparently nearly a third of a trillion die every day, and must be replaced. It is clearly evident why iron, the active element in red cells, must daily be included in the diet in sufficient amounts.

Iron is contained in red cells in a compound called hemoglobin, which is related to the chlorophyll of plants, and is probably produced from it. Its chemical formula is $C_{3032}H_{4816}O_{872}N_{780}S_8Fe_4$. The amount of iron (Fe) is small; nevertheless it permits the red cells to take in large quantities of oxygen. They normally take in oxygen at the rate of a quart every four minutes while the body is at rest, and perhaps a quart every half minute during severe exercise.

The red blood cells are formed in the red bone marrow, the soft inner part of certain bones (in adults, chiefly the skull bones, the ribs, the sternum and the pelvic bones, but in children, all bones). Hemoglobin is formed from substances in the food, carried from the small intestine to the bone marrow, and partly from salvaged iron from worn out red blood cells. Blood cells are retained in the marrow until mature and then discharged into the blood stream. An active principle formed within the body and from food (the erythrocyte-maturing factor) is necessary to bring red cells to maturity.

Destroyed red cells are removed from the blood in the spleen and elsewhere. Most of the iron is lost from them, and leaves the body in the bile, but some of it again enters the bone marrow and is used for making new red cells. However, there is never more than a small reserve of iron in the body.

As will have been noted, the red marrow, the spleen, and the liver are intimately associated in producing and maintaining the red cells and their hemoglobin.

The Spleen.

The spleen is an organ not absolutely essential to life, but it plays a useful role as a reservoir for red cells, from which they can

be discharged when there is extra need for oxygen carriage. Such need occurs during exercise; at high altitudes where the oxygen pressure in the atmosphere is low; and in heart disease, when breathing is difficult. Discharge from the spleen occurs by means of contraction of its capsule of fibrous tissue and muscle fibers. Such contractions normally occur during physical exertion and also during excitement. It appears that the old phrase "venting one's spleen" as a synonym for a display of anger was not far from the truth.

Because of its activities in "making over" the worn out red cells, by salvaging iron and the like, the spleen has been called the blood's "repair shop."

In certain forms of anemia, the spleen appears to be particularly active in blood destruction, and its removal results in cure.

Tests of Red Cells.

Clinical evidence is furnished by counting the total number of red cells; noting the presence of young cells, which are not normally found in the blood, and the presence of cells of abnormal size or structure or form; measuring the percentage of hemoglobin; determining the color index, or the ratio between hemoglobin and number of cells; and measuring the sedimentation rate, or the rate at which the red cells settle in the plasma when it is allowed to stand and is kept from clotting. All these tests have significance regarding the blood itself and various aspects of health and disease. For example, the sedimentation rate is increased in most inflammations.

The number of red cells is estimated by means of the counting chamber used for counting white cells. Hemoglobin tests are made by color comparisons.

Number of Red Cells.

An increase in the number of red cells is less common as evidence of disease than a decrease. An increase occurs normally after muscle exercise, in excited emotional states, and during exposure to high external temperatures. The increase may be relative rather than absolute when the water-content of the blood is decreased.

A gradual increase in the total number of red cells may occur as an adaptive process in those who habitually live in a high altitude, or in those who because of disease have a lowered oxygen tension in the arteries. In such cases, the excess is due to greater production of red cells. Except in such conditions there is no advantage in having more than the normal number; in fact, no treat-

ment, by iron or otherwise, will increase the number beyond the normal unless there is an abnormal need for them.

Anemia.

The term anemia has already been mentioned as describing a lack of blood locally in a part of the body. It is also used to describe a *systemic disease* due to changed quality of the blood. In the disease anemia there are either *too few red cells*, or *too little hemoglobin* in each cell. In some forms of anemia the blood is deficient in both these respects.

Obviously, when the oxygen-carrying power of the blood is reduced for either of the reasons mentioned, less oxidation can take place in the tissues, and less energy be liberated unless an increased rate of the heart and circulation compensates for the deficiency. Usually compensation is only partial, and because of deficient oxidation in muscles, the person with anemia tires easily. Also, he becomes breathless on exertion. He is uncomfortable in action and is usually willing to be called lazy provided he is permitted to remain quiet. It is, of course, important to cure anemia, since both physical and mental vigor depend upon a satisfactory supply of oxygen to cells.

The causes of anemia are numerous. First, it may be due to *loss of blood* by hemorrhage, either a large loss at one time or a small loss continued. For example, excessive or too frequent menstruation may lead to anemia; so also may even the minute amount of bleeding from sore gums or from hemorrhoids, if continued over a long period of time.

Second, anemia may be caused by the *destruction of red blood cells* by poisons (e.g., lead) or by parasites. Anemia is probably more often caused by the parasites of hookworm and of malaria than by any other parasitic cause. Almost all of the bacteria causing acute or chronic infections tend to cause some degree of anemia, probably because the bacterial toxins interfere with normal activity of bone marrow.

Third, anemia may be due to a *faulty diet*, or, more rarely, to faulty absorption of a good diet. The latter may occur in certain gastrointestinal diseases. Nutritional anemia, as it is called, occurs most frequently when the diet is deficient in iron. However, it is often not merely iron that is deficient; other substances that enter into the formation of red cells must also be supplied. Anemia occurs from general *undernutrition* with a deficient intake of protein and of vitamins.

The remedy for anemia of the three types mentioned depends upon the degree. In some cases, transfusion must be used. Ordinarily the remedy is a correct diet, perhaps supplemented by iron-containing medicine.

Pernicious Anemia.

The adjective applied to this type of anemia suggests that it is particularly serious. That was the case until 1927; it was invariably fatal. However, in that year two physicians, Minot and Murphy, of Harvard University, discovered that the feeding of patients with large amounts of liver brought about their recovery—a recovery that lasted as long as they continued to take enough liver. Later it was found possible to prepare an extract of liver, to be taken as medicine.

The difficulty in pernicious anemia is in the formation of red cells, not hemoglobin. It appears to be caused by a defect in the stomach. Normally the stomach produces a substance (the "intrinsic factor") which acts upon a substance in the diet ("the extrinsic factor") to form a third substance, the hematinic principle or anti-anemia principle. The latter is absorbed from the stomach and stored in the liver. The same process takes place in animals, which explains why the taking of liver is beneficial to those in whom the foregoing process does not take place normally.

Nothing is known of the nature of the intrinsic factor formed in the stomach, nor of the reason why it is sometimes not formed. Also, nothing is known of the nature of the extrinsic factor found in food, except that it is present in foods that contain vitamin B_2, especially in meats that contain it and in yeast; if it is a vitamin, it is one that has not yet been discovered.

In some cases, the use of an extract of stomach to provide the intrinsic factor, plus a diet containing the foods known to contain the extrinsic factor, will cure pernicious anemia.

Liver is often used for the other types of anemia as well as the pernicious type; it is desirable that liver be included in all diets occasionally.

Platelets.

The third variety of corpuscles in the blood, the platelets or thrombocytes, are probably not a special kind of cell but small fragments of larger cells found in the bone marrow. Much is known of their action, but little of their nature. They are extremely small, and difficult to see and to count because they readily disintegrate outside the blood. Their function is that of initiating the clotting

of blood and of protecting the lining of blood vessels when injured. In certain diseases in which their number is reduced, bleeding occurs under the skin, giving purplish areas.

Clotting of Blood.

Outside the body the blood does not long remain fluid; in fact it normally clots in from 2 to 5 minutes. By this process, fatal hemorrhage from wounds to blood vessels is prevented. It is effective in all but injuries to large vessels, from which the flow is rapid—in which case, the flow may be checked by pressure upon the bleeding spot for a long enough time to permit a clot to form, or, in extreme cases, by shutting off the flow by a tourniquet applied between the wound and the heart.

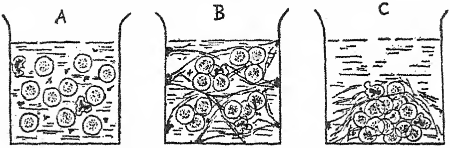


FIG. 118.—The coagulation of the blood: A, normal blood; B, the formation of fibrin from colonies of thrombocytes enveloping the formed elements; C, the separation into the coagulum and supernatant serum. (From Burton-opitz, "Elementary Manual of Physiology," W. B. Saunders Co.)

The essential feature of clotting is the formation from the blood plasma of a substance called fibrin. It appears first as fine threads, which ultimately interlace in such a way as to enmesh the blood cells, both red and white. Later, the fibrin shrinks, which presses out the fluid (serum).

Several substances in the blood plasma take part in this process; it is chemically one of the most intricate series of reactions that occurs in the body. The platelets are essential for starting it, and calcium must be present in the blood in sufficient amounts in order to have it take place promptly.

A delayed clotting time is characteristic of the hereditary disease hemophilia, which is manifest only in males, but is transmitted through females. It is a rare disease. Most "bleeders" or "slow clotters" do not have this disease, but a condition that is preventable or remediable.

Clotting time is tested before operations, and measures are taken to bring it to normal, usually by the administration of calcium

salts. Vitamin K is of value in certain cases with a tendency to bleed (e.g., certain types of jaundice).

Clotting may take place within the blood vessels in certain circumstances. Such a clot is called a thrombus. A thrombus may form at a spot where the lining of a vessel is roughened or injured, or where the blood current is unduly slowed. If it is large enough to fill the opening through the vessel, it obviously will interfere with circulation beyond it. The results are fatal if the clot occurs in a vital part not supplied with blood from other vessels. The most serious locations for thrombus formation (thrombosis) are in the coronary arteries of the heart and in the arteries of the brain, the latter causing one variety of apoplexy or "stroke" (the other sort being due to rupture of a vessel).

If a piece of thrombus becomes detached and travels from the site of its formation to another location, it is called an embolus. Again, the results depend upon where the embolus comes to rest.

The same mechanism which sometimes has such unfortunate results is, however, often beneficial, for it is a method of repair of blood vessels. In certain infections the organisms damage the lining of blood vessels, creating weak spots which might eventually rupture; but platelets gather at the area, glue themselves to it, and then disintegrate. The subsequent small clots that form at the area may in time become tough "patches" which serve very well to strengthen the vessel wall.

A substance, heparin, derived from liver, has recently been discovered to have the remarkable power of preventing blood from clotting. In some circumstances heparin may be used with life-saving effect.

Chapter 27

THE LUNGS

A pair of lungs contains 750,000,000 air sacs or alveoli, which if thrown together would make a balloon twenty feet in diameter. If the alveoli were spread out their total area would be one hundred times that of the skin. They contain nothing but alveolar air, which is air from the outside mixed with the air already in them from previous breathing. Before birth the lungs are not inflated, but normally become so immediately after birth, with the first contact with the atmosphere. Thereafter they function in a purely automatic fashion.

Oxygen Supply.

Both rate and depth of breathing are governed reflexly, and vary according to the body's need to take in oxygen and to give off carbon dioxide. When such needs are increased, breathing increases. For example, it increases for both purposes during exercise, at which time the active muscles need more oxygen and need to have the excess of carbon dioxide removed. In general, breathing is in proportion to the rate and amount of metabolism.

In certain abnormal conditions, also, breathing increases to meet physiological needs. For example, if the heart is unable to pump blood fast enough to the lungs, breathing is increased in an attempt to oxygenate more fully the smaller amount of blood that reaches the lungs. The rate may exceed the normal sixteen breaths per minute and each breath may be deeper. Labored breathing, at rest or on slight exertion, is a common symptom of heart trouble.

Compensatory increase in breathing also occurs when the red blood cells are too few or do not contain enough hemoglobin to carry the usual amount of oxygen to the tissues. In anemia breathing is usually normal at rest, but increased on exertion.

Naturally, breathing must be increased in diseases of the lungs that make the whole or any part of them less efficient than usual.

In some circumstances the automatic processes for supplying the tissues with oxygen are inadequate, and the tissues suffer temporarily or chronically from oxygen lack (anoxia) of varying degree. This may occur either in health or disease.

Anoxia.

The term anoxia means deprived of oxygen. It has reference not to the lungs nor the blood, but to the body tissues. Anoxia may occur in the diseases mentioned if the increased rate and depth of respiration proves to be inadequate to keep the tissues fully oxygenated. Also, it may occur when the inspired air contains certain chemicals (e.g., carbon monoxide) that interfere with the oxygen-carrying power of hemoglobin. It is one of the results of poisoning by certain narcotics. It occurs naturally when oxygen tension in the atmosphere is low, as at high altitudes. Finally, it is one of the results of shallow, rapid breathing from whatever cause, and possibly from shallow breathing at the normal rate.

The Hygiene of Breathing.

In ordinary quiet breathing, *tidal air* to the amount of 350–500 cubic centimeters (one pint or less) is breathed in and out at each breath. It mixes with the air already in the lungs and normally keeps the alveolar air at the correct composition in respect to oxygen and carbon dioxide. It appears that when the tidal air enters, the parts of the lungs in contact with the walls of the chest and the diaphragm inflate first, and if the breath is deep enough, the other parts of the lungs then inflate.

To take in a due amount of tidal air and to ventilate the lungs properly, the lungs should increase in size at all diameters at every breath. The intercostal muscles situated diagonally between each two ribs contract in such a way as to lift the ribs and increase the size of the thorax. Also, the diaphragm, the arched muscle stretching horizontally across the base of the thorax, alternately rises and falls, permitting the lungs to expand and contract. Although these muscles normally act involuntarily, they are capable of being used voluntarily for the purpose of taking deeper breaths.

The individual who breathes with normal expansion not only insures due inflation of the lungs and a due oxygen supply, but also he furnishes a considerable amount of assistance to the return flow of venous blood from the lower parts of the body to the heart, as was mentioned in Chapter 24. The habit of full breathing should therefore be cultivated.

Recent research suggests that minor degrees of anoxia as a result of rapid, shallow breathing may be more common than was formerly supposed. Those who inflate only a small portion of the lungs at each breath may be depriving their tissues of necessary oxygen and may suffer bad effects thereby. The symptoms are, in

lesser degree, those experienced at high altitude, and involve the nervous system, the circulation and digestion.

Although shallow breathing may be due to abnormalities of one sort or another, it is often due merely to habit. The habit should be overcome if possible, or at least the bad effects of it should be counteracted by occasional intervals of deeper breathing, provided that the lungs are in normal condition.

Vital Capacity.

Vital capacity is a term used to describe the maximum amount of air that can be expelled after a maximum inspiration. Such a breath is approximately eight times the amount of the tidal air, or approximately 3500 cubic centimeters, in the average healthy adult.

Although vital capacity is generally in proportion to the surface area of the body, it varies somewhat according to the use made of the lungs and the health of the lungs. Ordinarily, it is higher in males than in females; in athletes than in weaklings; in the young than in the old; in singers than non-singers; and in those with sound lungs than those with diseased lungs.

When vital capacity is low, breathlessness occurs on slight exertion, for which reason it is an advantage to keep the vital capacity at a normal level. It is thought that inborn conditions determine to some extent the ability to increase the vital capacity to the extraordinarily high levels exhibited in certain athletes (e.g., a famous Marathon runner, whose vital capacity is 5500). For the average individual there is no advantage in having more than the normal vital capacity, just as there is no advantage in breathing more deeply than normal, since ordinary lung capacity and ordinary breathing serve to take in all the oxygen that can be absorbed and that the tissues can use.

Diseases of the Lungs.

The most frequent diseases involving the lungs are infections. Three of these—pneumonia, tuberculosis and influenza—are responsible for the largest number of deaths from communicable disease. Two of them—pneumonia and tuberculosis—rank singly in the ten leading causes of death. However, in recent years much has been learned about their prevention and their cure, and the situation is brighter today than it ever has been in the past. In fact a considerable decrease in the morbidity and the mortality from all three of these diseases has occurred, owing to the application of modern preventive and curative methods.

Lung tissue is subject to other diseases, but only one of these, silicosis, is statistically important as a disease entity. Silicosis is a chronic condition of the lungs due to inhalation of fine particles of silica. The disease is common in workers in a variety of industries making use of sand, and is directly or indirectly responsible for many deaths. Silicosis is preventable by ventilation to remove dusts and individual use of protective masks.

TUBERCULOSIS

In the 17th century John Bunyan gave tuberculosis the title "Captain of the men of death." How prevalent it was at that time can only be guessed, but it is known that a hundred years ago, when vital statistics first became a science, it caused 500 deaths per 100,000 population annually, far exceeding all other causes of death. By 1900, the rate had dropped in this country to 202, but it was still the leading cause of death. In 1920 the rate was 150, and since then has fallen rapidly to a new low of 49 per 100,000 in 1938. It is now seventh on the list of causes of death. A large part of this enormous decrease in the death rate of tuberculosis is undoubtedly due to the concerted attack against it which has been going on during this century. The public has been told that tuberculosis is not hereditary but is an acquired and preventable disease, and has been told how to prevent it.

However, *from* 15–45 *years of age tuberculosis is still the chief cause of death.* A large proportion of the 420,000 persons who are ill and incapacitated by tuberculosis are young people in the most active years of life, not yet having reached their prime, and often destined not to do so.

Source of Infection.

Tuberculosis is a disease to which apparently the whole human race has been susceptible since even before the earliest recorded history. The same types of tuberculosis that now occur have been found in bones from the Neolithic Period and in mummies from ancient Egypt. Today, the disease afflicts all races. In this country, it is particularly prevalent among the Negroes and Indians. It is a disease not exclusively of humans; several species of animals are subject to it.

The cause of tuberculosis is the tubercle bacillus, discovered by Robert Koch of Germany in 1882. Tuberculosis among humans is caused largely by the human type of the tubercle bacillus, trans-

ferred from person to person by direct or indirect contact. Humans are also subject to bovine (cattle) tuberculosis, derived through milk.

Until the present century bovine tuberculosis was responsible for much tuberculosis in humans. It involved chiefly the bones, glands and intestinal tract, and occurred especially in children who had been fed on unpasteurized milk from infected cows. Today,

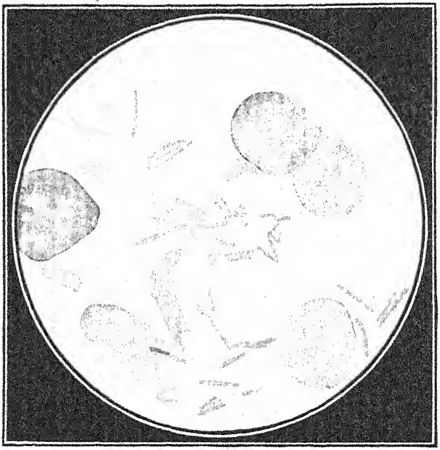


FIG. 119.—Tubercle bacilli (red rods) and pus cells as found in sputum in tuberculosis. (MacNeal.)

tuberculosis among cattle has been practically wiped out. Owing to the efforts of the Bureau of Agriculture, forty six states have an incidence of less than 0.5% of tuberculosis among cattle. Infected animals are destroyed as soon as the infection is detected. The same states also have adopted the government standards for pure milk, which include healthy cows as the starting point and pasteurization of milk as the conclusion. For these reasons, bovine tuberculosis in humans is rare today. "Hump back," which was most often due to tuberculosis of the spine, and other skeletal deformities due to bovine tuberculosis, are now seldom seen.

Today, it is the infected human who is responsible for the prevalence of tuberculosis. The lungs are the commonest site of the disease, and the organisms are given off in secretions coughed up and expectorated from them. It has been estimated that one patient may give off 3,000,000 bacilli a day.

The tubercle bacilli are able to remain alive outside the body longer than many other germs, especially on dust. It is believed that many individuals acquire the infection without ever having been closely associated with a case of tuberculosis, although the danger is probably many times greater in the case of those who live in households harboring the disease.

A special danger arises from the fact that frequently a person who is giving off tubercle bacilli does not realize the fact. In some people, the disease is comparatively mild at the start and perhaps for years does not cause the individual to feel sick enough to have an examination. Although he coughs, he attributes it to "bronchial trouble" or "catarrh" or to too much smoking, or some such cause. It is this type of case that is the source of many, if not most, infections.

Infection with Tubercle Bacilli.

From some source, discoverable or not, many children early become infected with tubercle bacilli, but very few become ill when tubercle bacilli are first received. The lung tissues usually overcome the bacilli and prevent them from doing any great amount of damage.

When tubercle bacilli arrive in the lung, the white blood cells gather around them and by a complicated chemical interaction between the bacilli and the white cells, *tubercles* are formed around the still living bacilli. After this happens, the bacilli are said to be "walled off." Usually in time the wall becomes of almost stony hardness owing to the deposit of calcium in it. A few bacilli from the lung usually migrate at an early stage to some of the lymph nodes in the region of the bronchial tubes, and the same process of tubercle-formation takes place in them.

While tubercles are being formed the child may feel as usual, although fever may be present for a few weeks, with fatigue and loss of weight.

The surrounding of the tubercle bacilli occurs as described only if the body's resistance is good. Occasionally the first invasion is not overcome in this fashion, and the disease tuberculosis begins.

As long as the wall of the tubercle remains intact, the bacilli are completely separated from the lung tissue, but they do not die, nor

do they excite the formation of antibodies. Instead, they cause the body tissues to become sensitized to their proteins, and as a result to be more susceptible to further harm from them. This *childhood* or *first infection* type of tuberculosis is therefore a hazard and should be prevented if possible.

Onset of the Disease Tuberculosis.

Infection with tubercle bacilli is to be distinguished from the disease tuberculosis. The latter occurs in only a small percentage of those who harbor the germs. Usually it occurs many years after the first infection, and is due to reinfection; hence it is called the *adult* or *reinfection* type of tuberculosis. Clinically, it is active tuberculosis, either acute or chronic.

Reinfection may arise either from the individual's own walled off bacilli or from bacilli newly received. In the former case, the defensive wall around the still living germs breaks down, allowing them to escape. In the latter case, bacilli enter usually through the air passages and establish themselves in air sacs, usually at the apex of one of the lungs. In either case, because the lung tissues have been sensitized from the first infection, they are more subject to harm than when they first received tubercle bacilli. Shortly an area become softened, and then a cavity occurs. The cavity usually communicates with a bronchial tube, through which destroyed tissue and mucus and tubercle bacilli are given off.

(*a*) *Lowered Resistance.*—Whether the individual infected in childhood will ever become ill as a result of his interned bacilli depends to a large extent upon the sort of life he leads. Anything that puts the body under physiological strain may disturb the relations between the body and its tubercle bacilli, and allow the latter to become active as injuring agents. Factors most commonly causing such physiological strain are *excesses*, of work, play or emotion, and *deficiencies*, especially of diet, rest and sleep. In some cases, another disease (e.g. diabetes) may be the predisposing factor. Not rarely tuberculosis follows recovery from a minor infection such as measles or a cold in those already predisposed by reason of their mode of living.

It has been noted that there is an "age of discretion" for tuberculosis, at about 30 years of age; if a person is free from the disease at that age he has probably learned how to live so as to avoid the activation of any bacteria that may be present in his lungs.

(*b*) *New Infection.*—As for infection from bacilli newly received, the same factors of general resistance are of importance. The body

has a native tendency to overcome tubercle bacilli, and in its normal state is not affected adversely by the small numbers of bacilli such as most people receive from time to time. However, few people are so resistant that they can overcome a large number of bacilli repeatedly received at short intervals. There is, therefore, special danger in living in the same house or working in the same quarters with a person giving off tubercle bacilli, and this is true in the case of those infected or not infected, and those in good health or poor.

Symptoms of Tuberculosis.

At the beginning of the activity of the tubercle bacilli, the symptoms are not at all definite. In fact, the disease cannot be diagnosed on the basis of symptoms alone; diagnostic tests must be done.

The following are symptoms that should be reported to a physician: loss of weight, loss of appetite, indigestion, fatigue or loss of "pep," a cough that "hangs on," a "stitch" in the side of the chest, feverishness in the afternoon, hoarseness or huskiness of the voice, a need for clearing the throat, spitting of blood, and sweating while in bed at night. All of these together might not mean tuberculosis, or one of them alone might give the clue for further examination.

Some of the symptoms of tuberculosis, as will be seen, are the results of destruction of lung tissue. But in the early stages the symptoms may be chiefly the results of absorption of toxins from a small area not yet greatly damaged.

Hippocrates, the "father of medicine" described lung tuberculosis accurately and gave it a name it still bears—phthisis (wasting), but it should be noted that wasting is usually a late symptom, not an early one, and that tuberculosis may exist in one who is of normal weight or even overweight.

Diagnosis of Tuberculosis.

The diagnosis of tuberculosis is beyond question when the patient gives off sputum containing tubercle bacilli. Obviously, this test cannot be used in the early stages before such sputum is produced. Similarly, the use of the stethoscope and of percussion of the chest will reveal cavities in the lung, but will not as a rule reveal any earlier involvement.

There are, however, two methods which are of great value in discovering early tuberculosis. One of these (the tuberculin test) shows whether infection has ever occurred, and the other (x-rays) shows whether disease has begun.

Tuberculin Tests and X-rays.

Robert Koch, the discoverer of the tubercle bacillus, also discovered tuberculin, a protein substance from tubercle bacilli, which he hoped would serve to stimulate immunity to the disease. It proved not to do so, but in 1907 von Pirquet and also Mantoux developed a form of tuberculin which is now used to make skin tests to determine whether infection with tubercle bacilli is present.

As stated, the first infection sensitizes the tissues, including the skin. If a minute amount of tuberculin be placed upon the skin, two days later a red spot with a raised center appears if such sensitivity exists. This is known as a positive reaction. It does not mean that the individual has tuberculosis, but merely that he is sensitive to tubercle bacilli as a result of having received them at some time in his life.

Tuberculin is a purified protein substance, and contains no tubercle bacilli, living or dead. It is applied in very dilute solutions, much as is the material used in the skin tests for allergy—and that is virtually what the tuberculin test is, a test of allergy arising from the presence of tubercle bacilli. The test is entirely safe.

The tuberculin test is done very widely among children and young adults as a means of distinguishing between those who need further tests for tuberculosis. Although the negative reactors are safe, at least at the time of the test, the positive reactors might conceivably have the disease.

Therefore all the positive reactors are given an x-ray examination of the lungs, since nine-tenths of tuberculosis occurs in those organs. If tubercles are present and are large enough and sufficiently calcified, they cast a shadow on the x-ray plate. Such a finding confirms the fact that infection of the childhood type has occurred. In some few cases, the x-rays will reveal that the tubercle bacilli have been active and have caused destruction of lung tissue with cavity formation, indicating that the re-infection or adult type of tuberculosis is present. In the former case, the individual is warned that he must observe certain precautions lest the tubercles break down or lest he receive a new infection from others. In the latter case, the individual needs treatment of the disease.

Many colleges, at least 178, have organized programs for the prevention of tuberculosis, and for the most part use tuberculin tests, followed by x-ray tests of positive reactors. It is reported that 30.5% of 32,000 college students are positive reactors, but that only about 0.6% have adult tuberculosis. Similar figures have been obtained in a number of groups of high school students.

As for the likelihood that the positive reactor will have the disease later if not at the time the first x-ray photograph is taken, his chances are definitely greater than those of the negative reactor, although the latter is by no means immune. Children who are positive reactors at the age of 6–7 years are said to be nine times as likely to have tuberculosis later in life as are those who react negatively at that age.

The negative reactor should have the tuberculin test repeated annually. The positive reactor should have an x-ray examination annually, for the x-ray shows evidence of the beginning of tuberculosis as much as two or three years before symptoms appear and before it could be discovered in any other way.

Recovery from Tuberculosis.

Tuberculosis is a long, chronic disease, but the human body has a tendency to be able to check it, both at the first infection and at any re-infection. If the body is successful in its efforts at healing, the bacilli will be walled off again by the same process as occurred the first time, but the damage done to the lung cannot always be repaired so as to make it as efficient as before. Furthermore, some of the bacilli are likely to remain alive. Therefore the terms *healed* or *arrested* are used instead of *cured* to describe the end-results of successful treatment of tuberculosis.

The arrest of tuberculosis usually depends upon the promptness with which it is recognized and treatment begun. It has been stated that 80–85% of cases are moderately or far advanced when they first see a physician. In one of the states in 1936 in over 5,000 admissions to tuberculosis sanatoria the disease was in an early stage in 7% of cases, moderately advanced in 24%, and far advanced in 69%. When all cases are considered, the individual with tuberculosis has a fifty-fifty chance of recovery; his chances are better than 4 in 5 if treatment is begun early, and only 1 in 5 if begun late. The chances are excellent if the diagnosis is made by x-ray before any symptoms have appeared.

Methods of Treatment.

Modern methods of treatment of tuberculosis date back about one hundred years. Bodington in England in 1840 discovered that giving the patient complete bed rest, with a highly nutritious diet, and plenty of fresh air, helped him to recover. In 1885 Dr. Edward Trudeau, himself a victim of tuberculosis, introduced these methods in the sanatorium he built at Saranac Lake, New York. Since then

every hospital in the country uses these methods as the foundation for treatment.

In recent years another method—artificial pneumothorax—has also been adopted. It consists of introducing air into the pleural cavity surrounding the lung, in order to compress the lung. The more completely at rest the lung can be, the less it moves in breathing, the better its chance of healing. This is the principle underlying bed rest during active tuberculosis. Artificial pneumothorax makes the lung nearly motionless. As the lung gradually expands, the process of introducing air must be repeated, usually at intervals for a period of two to five years. In some cases, a surgical operation on the ribs is performed, in order to compress the lung permanently.

Although the treatment of tuberculosis can be successfully carried out at home, it must always be under medical supervision. For many reasons, hospital care is preferable for the patient and also for the protection of other members of the household.

After arrest of the disease, the patient must still be under a physician's care for some time in order to avoid a relapse. Usually the patient cannot return to work at once, and perhaps is never able to return to his former work.

When discovered at a very early stage, occasionally tuberculosis can be treated by artificial pneumothorax without bed rest, and the patient can remain at work.

Hospitals.

Tuberculosis had been recognized as communicable from person to person by Avicenna, the Arabian physician, in 1037. Yet the first hospital for isolation of cases seems to have been established in Naples, Italy, in 1760. A few years later (1782) the Edict of Naples required that all those ill with tuberculosis should be isolated, all their property disinfected, and their clothing burned, under penalty of fine. The city agreed to buy new clothing for those who recovered —a promise it seldom had to fulfill, since few recovered from the disease in those days.

In this country, the first free hospital for tuberculosis was founded in 1857, in Boston, and the first state hospital in 1898, in Massachusetts. Although isolation of the ill was one of the reasons for the subsequent rapid increase in tuberculosis hospitals, an equally important reason was that there be opportunity to apply the newly developed methods for treatment. Today it is reported that there are approximately 100,000 beds in 1,200 hospitals for those ill with tuberculosis. These are supported by federal, state, county, city, and private funds.

Many sanatoria and hospitals conduct clinics for the diagnosis of tuberculosis. Some of them send out traveling clinics to communities having no local facilities. Also, many public school systems provide tuberculin tests, and x-ray examination if necessary, for students.

Christmas Seals.

One of the important factors in reducing the rate of tuberculosis has been the money that the public has contributed through the purchase of Christmas seals. Such seals were first used in Denmark in 1904. In this country they were first sold in a limited way in Wilmington, Delaware, in 1907, and in the following year throughout the country by the American Red Cross. The National Tuberculosis Association later took over the sale of seals, and has conducted it annually for many years. This organization was founded in 1904, for the purpose of demonstration, education, and research in regard to tuberculosis. With the proceeds from the Christmas seals it has carried on non-official work of far-reaching significance, especially in the forming of public opinion, which is a necessary preliminary to official work.

PNEUMONIA

Lobar pneumonia, commonly called simply pneumonia, is an infection of one or more lobes of one or both lungs. It is due to specific organisms, the pneumococci, of which there are 32 known types. Any given case of pneumonia will be due to one type predominantly. Those that were first recognized, Types I, II and III, are the most common.

As a result of infection, the air-sacs fill with serum and pus, which consolidates the infected area; no air can enter, and the patient suffers from lack of oxygen. Toxins are formed and are absorbed throughout the body, giving a profound degree of illness.

Pneumonia is an ancient disease. Its name was given to it by Hippocrates, who described its clinical symptoms accurately.

Symptoms of Pneumonia.

Usually the first symptom of pneumonia is a chill, accompanied by fever, embarrassed breathing, and cough, often with blood-flaked sputum. After the temperature has reached a high level, it usually drops by crisis (that is, suddenly) but the patient remains ill for some time. Recovery may take weeks.

Pneumonia is fatal in many cases, probably in at least 30% of cases not having proper treatment. It is particularly likely to be fatal in the aged, the feeble, and the alcoholic. However, even the robust may succumb.

Susceptibility.

Susceptibility to pneumonia is general but is increased by certain factors in the individual or the environment.

It appears that extreme exposure to cold may induce infection. Laboratory experiments have shown that when rats are inoculated with pneumonia germs nearly half develop the disease if they have previously been exposed to cold, but only one-tenth of the rats who have been kept in normal temperatures. Humans in really cold climates are, however, less susceptible to pneumonia than those in climates that are variable. It is thought that changes from warm to cold, especially sudden changes, may be of greater significance than prolonged cold of itself.

Also, it appears that alcoholic intoxication destroys resistance to pneumonia. In the case of rats, even those rendered immune by serum become susceptible again under the influence of alcohol. The explanation is that the white blood cells remain in the capillaries and do not migrate to combat the pneumococci.

The effect of ether anesthesia is somewhat similar to that of alcohol. When rats are exposed to ether and then inoculated with pneumonia one-third develop the disease.

Pneumonia may be one of the complications of a neglected cold. In at least three-fourths of the cases of pneumonia, there is a history of a cold within the two previous weeks. Many of these colds had been neglected—that is, the patient had kept at work and used self-prescribed treatment. It appears that the organisms causing colds sensitize the lungs to pneumonia.

Men as a class are more susceptible to pneumonia than are women, and the Negro race than the white race, although susceptibility is high in all humans. The disease also occurs frequently in domestic animals and in wild animals in captivity, in which it is the chief cause of death.

For many years attempts have been made to discover a vaccine that would increase the resistance to pneumonia. Some success has recently been reported by physicians of the United States Public Health Service. The experimental vaccine appears to have great promise.

Treatment.

A serum is now available for use in the treatment of each of the thirty-two types of pneumonia. In a single commercial laboratory 20,000 rabbits, each in its outdoor hutch, and 350 horses, are constantly used in producing these sera. Also, there is a drug, sulfa-

pyridine, which often gives excellent results in pneumonia. The effect of the drug is to check the activity of the bacteria and to prepare them for phagocytic action; the effect of the serum is to "neutralize" the bacteria by antibodies.

In any given case of pneumonia, the treatment may be either the serum or the drug or both, according to the physician's judgment. In addition, oxygen may be given if the lungs are not able to take in enough to keep the tissues well supplied. Throughout the illness, good nursing is essential; in fact nursing saved many lives before specific treatment was available.

Since the serum for one type of pneumonia is of no use against another type, it is always necessary that the sputum be examined and the pneumococci be "typed." This laboratory service is provided by local or state departments of health, some of which also provide serum.

As a result of the new forms of treatment, the mortality rate for pneumonia in 1939 was 15% less than in 1938. It is thought that if treatment is given early enough, before consolidation of the lung occurs, nearly all lives can be saved. After recovery from pneumonia and a suitably long period of convalescence, health is usually completely restored.

Bronchopneumonia.

Bronchopneumonia begins in the small bronchial tubes and then involves the tissues of the lung. Usually it is secondary to other infections, such as influenza. It is particularly serious when due to influenza, but may be less so after other infections, except in the case of infants and the aged. In the latter it often occurs as the conclusion of any illness that requires remaining flat on the back for a long period, as during the healing of a fracture. In such cases the infection begins in the under part of the lungs where congestion takes place owing to poor circulation.

In statistical reports, bronchopneumonia often is not distinguished from lobar pneumonia, but the two differ in that bronchopneumonia is secondary and due to a variety of organisms, whereas the latter is a specific communicable disease always due to the pneumococcus. Together the two types of pneumonia are sixth among the leading causes of death, and first among the communicable diseases.

Pleurisy.

The lungs are covered with two layers of membrane, called pleurae. One pleura fits closely to the inside of the chest and the

other to the lung. Ordinarily there is no space between the two layers, but only a small amount of moisture which permits frictionless motion in breathing. If the pleural membranes become inflamed, as in the disease pleurisy, motion is no longer frictionless, and pain occurs on breathing, with the symptom known as a "stitch in the side." In some cases, fluid may form between the two pleurae; when the fluid is pus, the condition is called empyema.

Pleurisy is mentioned here because the more severe types are usually due to one of the two diseases just described, pneumonia or tuberculosis.

INFLUENZA

Influenza is a specific communicable disease in which the lungs are often involved. The layman as a rule uses the term "grippe" for a cold with constitutional symptoms such as fever and aching of the back, and the term influenza for a still more severe cold of the same sort. But influenza is not a cold. It is a separate disease, due to a filterable virus not present in the common cold nor the "grippy" cold. It is a far more serious disease, with a high mortality from the associated pneumonia.

It is true, however, that the symptoms may resemble a cold at the start. Influenza should be suspected whenever respiratory symptoms are accompanied by fever and prostration (a marked feeling of illness and weakness). One of the important reasons for giving due attention to a cold is that it may be the onset of influenza. But fever and prostration may indicate influenza, even though respiratory symptoms are trivial or absent.

Influenza Epidemics.

Although influenza is not a new disease, it appeared in a most virulent form in the historic pandemic of 1918, which spread to the antipodes, and killed 21,500,000 people. It was described by the British Minister of Health as "not lower than third, perhaps second, upon the roll of great pestilences." Its rivals were the epidemics of plague in the reign of Justinian and in the 14th century, the latter called the Black Death.

Since then, the virus of influenza has been constantly present in communities, and has been responsible for numerous lesser epidemics. Presumably a number of persons are carriers of the virus. The epidemics vary from year to year both in respect to the symptoms and the severity of the attacks. In some epidemics intestinal symptoms are frequent.

In spite of all the harm it caused, the 1918 pandemic had two good effects. First, it drew the attention of the public as never before to the need for sanitary habits in the presence of infection. Second, it showed the wisdom of prompt treatment. Many of those who had previously boasted of their ability to "fight a cold" learned through observation or experience that it was better to surrender at once to anything that resembled a cold, lest it turn out to be first influenza and then pneumonia.

Immunity.

As with many virus diseases, individuals appear to vary greatly in their susceptibility to influenza. Those who are most susceptible to it are not necessarily those most susceptible to colds. Some individuals appear to be naturally immune to it. After an attack of the disease, some degree of immunity may occur; antibodies have been recovered from the blood of those who have recently had influenza. The immunity appears to vary markedly in both degree and duration, however.

Since the virus has been isolated from washings of material from the nose and throat of patients, and the virus is known to stimulate antibodies, it seems likely that a vaccine may eventually be available to prevent influenza. Such vaccines have been successfully used in laboratory animals, and experimentation is now being carried on among humans.

Chapter 28

THE AIR PASSAGES

Before reaching the lungs the incoming air passes through a series of passages beginning with the nose and ending with the finest of the bronchial tubes leading into the alveoli of the lungs. These passages serve a useful purpose, in that they change the physical qualities of the outside air, preparing it for entrance into the lungs. They serve their purpose if the space through them is not obstructed in any way, and if their membranes are healthy and active. Although obstruction is comparatively rare, disease of the respiratory membranes is extremely common. In fact the upper air passages are infected more frequently than any other part of the body, and this in spite of the fact that incoming air passes first through the nose, which possesses an elaborate mechanism for air purification.

The Nose.

From each nostril a passage extends horizontally backward and vertically upward for some distance, to unite at the rear in the upper part of the throat, the nasopharynx. The floor of the nasal passages is the roof of the mouth. Between the two passages is a vertical bony and cartilaginous partition, the septum.

From the side wall of the interior of each nasal passage project three scroll-like structures, the turbinate bones.

Leading into the nasal passages are the ducts from four pairs of sinuses, and the tear ducts from the orbits.

The function of the nose is that of (*a*) warming and moistening the incoming air before it reaches the alveoli of the lungs, where cold dry air would be irritating; (*b*), removing foreign matter from the air, including bacteria; and (*c*) serving as the path of entrance for sensory stimuli of smell. To serve as an organ to smell, the nasal membranes in the upper part of the nasal chambers contain the receptors of the olfactory nerves.

Air-conditioning Function of the Nose.

Warming and moistening of incoming air is accomplished by virtue of the mucous membrane with which the nasal passages are lined. This membrane is continuous all through the respiratory

tract. It is the same continuous sheet of membrane that covers the surface of the eyes, and forms the lining of the lids, the middle ears, and the whole of the digestive tract. Like all mucous membrane, it is glandular epithelium and produces *mucus.*

Air entering the nostrils passes over the entire moist surface of the nasal passages, including the turbinate bones, and also circulates through all the sinuses. The total surface area of these regions is as much as that of the entire face and neck. Air passing over this large, moist area takes up a good deal of moisture and is nearly saturated when it reaches the lungs. Also, it has nearly reached body temperature.

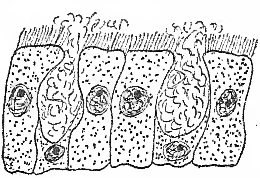


FIG. 120.—Mucous membrane of the trachea, showing cilia and mucous cells discharging mucus.

The mucus produced by this membrane is a somewhat sticky fluid constantly flowing slowly toward the back part of the nose and downward through the nasopharynx and pharynx. With it go any foreign particles that have been enmeshed in it, and that would be a source of irritation if not removed. The mucus increases in amount in response to a special need for its cleansing function (i.e., in response to irritants).

One characteristic of the nasal mucus is especially valuable; it contains an antiseptic substance, *lysozyme,* which normally dissolves many of the bacteria commonly found in the inspired air.

The nasal membrane is still more effective for cleansing purposes because the cells of which it is composed contain *cilia.* These are microscopic, hair-like processes attached to the cells. They are in constant motion, back and forth, and they always wave most strongly backward toward the nasopharynx. It is computed that mucus from the remotest part of any sinus can travel to the throat in thirty minutes. Cilia are present on the mucosa throughout the respiratory tract, except in the air sacs themselves, on the vocal cords and in part of the pharynx. There is an area at the top of the posterior wall of the pharynx where cilia are absent, and at which point infection begins in many colds.

Growth of bacteria on the nasal membranes is difficult if not impossible, as long as mucus is normally secreted and the cilia wave.

Further protection against the entrance of foreign material into the respiratory tract is furnished by the *hairs* just inside the nostrils,

and by the *turbinate bones* which nearly fill the cavities of the nose, and act as a barrier to prevent anything except gases and fluids from passing beyond them.

Obstruction of the Nose.

Obstruction of the nose may occur as a result of *deformity* of its bony structures. Accident may fracture the bones of the nose and disarrange its architecture. It is important whenever the nose is injured to make sure that fracture has not occurred, or that it is properly set so that it will heal without obstructive deformity. If deformity already exists (e.g., a deviation of the septum from its central vertical position) it is occasionally, but not frequently, desirable to have it operated upon.

The turbinate bones are subject to *hypertrophy* (overgrowth) as a result of long continued infection of their membranes. Such a condition is better prevented than cured. Operations upon these bones may sometimes, but not always, improve matters.

One of the results of prolonged nasal infection may be the formation of soft tumor-like masses called *polyps*, which may obstruct breathing to some extent. They are easily removed and will remain absent provided the infection can be cleared up.

Finally, acute or chronic *swelling* of the mucous membrane of the nose may cause obstruction.

Rhinitis.

Inflammation of the membrane lining the nasal chambers is called rhinitis. The membranes are swollen, which causes a "stopped up" sensation. Much watery mucus is secreted; the nose "runs." Sneezing usually occurs as a protective reflex, to assist in removing excess mucus together with irritants. When rhinitis is present, other parts of the respiratory tract may be, and usually are, affected at the same time.

Rhinitis may be caused by irritants in the atmosphere, such as dust, fumes and vapors. A common cause is the pollen from plants, giving hay fever. Allergens received from foods and drugs may have a similar effect. Also, rhinitis may be caused by unfavorable temperature and humidity of the atmosphere, the conditions that are most likely to affect the nasal membranes being hot, dry air; cold, damp air; or sudden changes. Finally, rhinitis may be due to infection.

Many causes of rhinitis act only temporarily, the inflammation subsiding almost as soon as the cause is removed, or shortly afterward. But if long continued, chronic inflammation may ensue.

The commonest cause of rhinitis is infection. It is this which is known as a "cold."

COLDS

"Nothing but a Cold."

The commonest of all communicable diseases, and the commonest of all illnesses that afflict mankind, is the "common cold." It outnumbers any other disease twenty-five to one.

It is estimated that the people of the United States have 200,000,000 colds each year, as follows: 15%, one cold; 30%, two; 26%, three; 14%, four; 14%, five.

According to studies of the United States Public Health Service, 90,000,000 work days are lost each year because of colds, with a money loss of three billion dollars.

These statistics refer only to colds. Complications arise in many colds, leading to other diseases that are recorded under their own names with no reference to the colds that started them. Were the end-results of colds to be included in the statistical reports regarding them, the figure would be staggering.

The question arises, what does medical science offer in the way of prevention of colds, and what can the individual do to carry out such preventive methods?

The Nature of Colds.

What is popularly called a cold is an acute infection of the upper air passages. In medical terminology an infection is often named according to the part involved, with the addition of *-itis*, meaning inflammation. According to this nomenclature, a cold in the nose is called rhinitis; in the throat or pharynx, pharyngitis; in the larynx, laryngitis; in the trachea, tracheitis. Rhinitis is also called coryza.

In the typical cold, the inflammation is likely to involve all the areas mentioned, and the sinuses as well. What is known as a "chest cold" is bronchitis, an infection of the bronchial tubes, which occurs in perhaps a third of all colds.

Bacteriology of Colds.

A *filterable virus* and a number of different *pus-producing organisms* have been identified in the secretions given off from the nasal passages during colds. In the typical cold that begins in the nose, it is thought that the virus is the first to cause infection, and that it lowers the resistance of the nasal membranes to such an extent that the bacteria normally present and harmless in the nose multiply

and start a pyogenic infection. This usually happens within a day or two of the onset of a cold.

It appears that in some cases the activity of the pus germs may have been started by other predisposing factors than a virus infection. This seems to be particularly true in colds apparently beginning in the throat, trachea, or bronchial tubes, with or without nasal infection.

Symptoms of a Cold.

The first symptom of a cold is a feeling of discomfort in the membranes of the upper air passages. A *dry and irritated feeling* in the nose or in the nasopharynx above and behind the soft palate can often be detected twenty-four hours before any other symptoms appear. Dryness of the throat may cause a "scratchy" feeling; dryness of the larynx may give slight hoarseness or roughness of the voice; and dryness of the trachea may give a sense of "tightness" behind the upper part of the breast bone. A slight cough from irritation of the throat, larynx or trachea may be the first evidence that a cold is beginning.

The foregoing symptoms are frequently not noted or are disregarded. They may not mean the onset of a cold, but in most cases they do. A beginning cold could usually be detected before it produces the well known symptom of discharge from the mucous membranes.

The *discharge* from the nose in a cold is at first watery. It is believed that the cold virus excites no other type of discharge. However, as soon as the pus-producing bacteria begin activity, the discharge becomes thick and whitish or yellowish. In the recumbent position, much of the discharge passes down to the throat by the nasopharynx, which fact may mislead a person into thinking that the discharge has ceased over night. Discharge from the membranes of the throat or trachea may or may not be coughed up. In the early stages often the cough is dry and unproductive, and later is "loose" and productive.

Like all bacteria, those causing colds produce toxins that are absorbed and circulate throughout the system, giving *constitutional symptoms* such as fever, headache, backache and a general feeling of sickness. Such symptoms often are present at the onset, but during the first day or two in colds beginning as a virus infection, these symptoms are often not marked. They tend to become more conspicuous as the secondary invaders become active.

Because the infection may, and usually does, involve the sinuses, the head may feel "full" and the wits dull, and there may be a diffuse or localized headache of some severity. Also, ear symptoms may arise from the swelling of the tubes to them. The eyes are usually somewhat inflamed.

Duration of a Cold.

The infection caused by the cold virus is of short duration. It is the "slight cold," which is at its worst the first day, much better in three or four days, and gone in a week. The "hard cold" is one in which the pyogenic bacteria are active. It usually reaches a climax of severity on the third or fourth day, gradually improves (if properly cared for) and is gone in two weeks. Unless a cold is cured in two weeks, it is likely to continue for six or eight weeks as a subacute infection; or indefinitely, as a chronic infection. The longer duration is particularly likely if complications arise.

Complications.

Inflammation of the eyes, the auditory tubes and the sinuses often occurs in colds, and this may progress, in any of these areas, to severe infection, as has been stated elsewhere. Also, a considerable number of colds lead to bronchitis. The most serious complication of a cold is pneumonia, the danger being greatest at the height of the purulent discharge, on the third and fourth day of the infection.

Complications often arise in more remote parts of the body. In children, pyelitis (infection of the pelvis of the kidney) and appendicitis are not uncommon sequelae. The same may occur in adults. Not only may a variety of new infections result from a cold, but existing infections may be activated. For example, gastric ulcer or a gall bladder infection may follow a cold, or, if already present, may be made worse.

"Catching Cold."

Colds are transmitted from person to person by the usual modes of direct or indirect contact. *Droplets* carried away from an infected person on his breath when he coughs or sneezes may reach a person some distance away. The velocity of a sneeze is 150 feet per second. The bacterial content of a sneeze may run into millions. Furthermore, bacteria may remain alive in the air for several hours, especially if the air contains particles of dust which acts as floaters for them.

In households or in any close group association, droplet infection seems almost inevitable. Those who associate with others at all

are certain to be exposed to droplets if colds are present. Although germs may be carried on articles handled by the infected, most people probably acquire their colds by the more direct forms of exposure. However, a person not exposed directly to infected persons may acquire a cold by chance exposure to *infected articles* (e.g., at a soda fountain, by drinking from a glass improperly washed after its previous use by a person with a cold).

Fig. 121.—A sick man at confession; the priest is covering his mouth with a cloth in order to protect himself against infection. 15th century wood-cut. (Ciba Symposia.)

Local Predisposing Factors.

Certain local conditions in the respiratory tract predispose to infection, either by one's own hitherto dormant germs, or by germs newly acquired from others. A tissue that is irritated, or one in which infection is already present, or one in which the circulation of blood is slowed (congested) or deficient (anemic) offers less resistance than sound tissue. In the nasal membranes resistance is specifically lowered by any factor that disturbs the normal flow of mucus, or lessens its antiseptic properties, or slows the action of the cilia.

Clinically it has often been noted that the following local factors reduce the resistance to colds: (*a*) irritation of the membranes by dust and certain fumes; (*b*) chronic infection of the nose or sinuses; (*c*) adenoids, when large and infected; (*d*) certain atmospheric conditions of temperature and humidity, especially hot, dry air, cold damp air, or a sudden drop in temperature. The local effects of alcohol and tobacco have been found by some investigators to be predisposing factors in a few individuals.

The local changes that lower resistance to colds may be a local manifestation of a constitutional condition that affects the mucous membranes.

Constitutional Predisposing Factors.

Any condition that lowers the general resistance of the body may make the nose and throat more susceptible to colds. This is especially true of susceptibility to the secondary invaders, the pus germs, always present in nose and throat. However, it appears to be equally true of the virus in the case of those who carry the virus or received it at a time when general resistance is low.

Among the factors which most authorities agree to be of greatest importance is that of *over-fatigue*, especially in the case of adults. A *poor diet*—one lacking in any of the dietary essentials—affects all tissues, and seems to be the cause of susceptibility to colds in children and adults alike. Apparently any dietary deficiency is as important in this respect as any other. There are some who believe that a diet that leads to *constipation*, or constipation from any cause, will increase a susceptibility to colds. Others have found *overeating*, especially of sweets, to be a contributing factor.

The effect of *imperfect temperature regulation*, with the resulting tendency to chilling of the whole or part of the body, impresses many physicians as the immediate predisposing factor in the vast majority of colds. This factor requires separate consideration.

Cold and "Colds."

Colds were presumably given this otherwise meaningless name because they were observed to follow exposure to cold. Modern opinion confirms this observation but stresses the *individual reaction to cold* rather than cold itself. If a person's reaction to it is good (i.e., if he does not become chilled), cold will not give him a cold.

For an individual to catch cold from exposure to cold, it seems to be necessary that he (*a*) be susceptible to chilling; (*b*) actually be chilled; and (*c*) either have or acquire the virus at the same time.

It is said that Eskimos and those on expeditions to Arctic climates do not have colds until someone arrives in their midst with a cold. The explanation might be either that the Eskimos and explorers did not carry cold virus or that when they became cold they did not become chilled.

In the temperate climate colds are commonest in cold weather, and they occur most frequently in indoor workers whose adjustments to cold are often far from satisfactory. A certain group of office workers in New York were reported to have colds nine times as

frequently as taxicab drivers in the same city. Undoubtedly indoor workers in close association with others are more exposed to the virus; but the difference in susceptibility to chilling may well be an equally important factor. Thus it appears that indoor heat may be more fundamentally causative of colds than outdoor cold.

Those whose temperature regulation is not adequate would do well to try to make it so, and in the meantime should guard against *general chilling* by prolonged exposure to cold while inactive and insufficiently clad, and any sort of *local chilling* such as that from draughts or wet feet. Even those with good temperature regulation should not tax it too greatly.

Such precautions are, of course, particularly desirable for those who may be *carriers* of the virus as well as of the pus-germs, or who are so *constantly exposed* to these organisms that they might receive them at almost any time. The majority of those who spend a great deal of time indoors and in association with others fall into the latter category. It has been suggested that those with chronic sinus infection are the most likely to be in the former category as chronic carriers of the virus.

Preventing Colds.

Unlike some of the infections, colds seem to be virtually inevitable in the present stage of development of our hygienic and sanitary habits. Nearly everyone with a cold goes about among his associates sowing the seeds of disaster for them because he thinks a cold is "nothing but a cold."

One of the two basic methods of preventing colds is the *avoidance of infected persons*, insofar as is possible. The susceptible, or in fact anyone, should leave the vicinity of those who are sneezing and coughing. If that is impossible they should (but probably will not) feel free to remind a careless sneezer or cougher to cover his mouth and nose. If obliged to talk to a person with a cold one should do so from as great a distance as convenient, and certainly not face to face. In dormitories and Army camps, turning the cots so that they come head to foot has been of some assistance in checking the spread of colds.

Although it may be necessary to mingle with others in some circumstances, as in street cars and in working places, those who are susceptible to hard colds should avoid any unnecessary contact with crowds. Also, they should avoid unnecessary use of public eating places where sterilization of dishes is doubtful.

The second basic method of prevention is that of keeping the resistance of the membranes at a high level according to the principles mentioned. It appears, however, that *no amount of general or local resistance avails against virulent organisms freshly received from an infected person.*

Vaccines.

There is no vaccine to prevent the virus infection that initiates most colds. There are, however, a number of vaccines that are in varying degree useful against the secondary invaders that cause most of the trouble. The chances that a given individual will profit by a series of "cold shots" seem to be about fifty-fifty, but for many this chance seems to be well worth taking, especially as the vaccine does no harm even if it does not help. Many reports on series of individuals inoculated against colds show that they had less severe colds with fewer complications; and some reports show fewer colds as well as less severe. Vaccines are especially worth consideration in the case of those whose colds have a tendency to involve the ears or other vulnerable parts.

"Fighting a Cold."

This term is often used by those wishing to imply that they have too much courage and persistence, too much confidence in their constitution, or too many important business or social engagements to "give in" to a cold. Furthermore, they do not wish to be or to appear molly-coddles. George Washington, two days before he died developed a cold after severe exposure on a stormy December day. When he was urged to care for his cold he said, "Let it go as it came. You know I never do anything for a cold."

It is true that millions of colds are simple and uncomplicated and will recover in a few days whether one attends to them or not. But it is also true that millions of colds that would have remained simple and recovered rapidly if properly treated have become serious, even fatal, in the absence of treatment.

Bed Rest for Colds.

Hippocrates, four centuries before the Christian era, advocated bed rest as the treatment of colds. During intervening centuries this treatment lapsed, but in this century it is again being recognized by physicians that a person who goes to bed at the first sign of a cold is setting the scene for prompt recovery.

Those who feel that they cannot afford the time from work must think of the still greater losses they may incur if the cold that is

beginning happens to be one of those that will not subside under working conditions. Also, they must think of the responsibility for protecting their fellows from germs. The unpopularity of the person who starts an epidemic of colds in an office or a class can hardly be lived down, and rightly so.

The main physiological reasons why it is desirable to take to one's bed during a cold are that while in bed energy expenditure is at a minimum, metabolism is reduced to a low level and body temperature can be more easily regulated.

In the case of those who detect the onset of a cold during the irritative stage, staying in bed one day may check it. If a cold is not noticed until the watery secretion begins, three days in bed are usually necessary. If the discharge becomes thick, indicating secondary bacterial infection, it is best to stay in bed until medical judgment sanctions getting up.

In any case, no one with a cold should be out of bed while fever is present. To be certain what the temperature is, a fever thermometer must be used, when the mouth is neither heated nor cooled by previous hot or cold food or drink. Drugs that lower temperature, such as aspirin, confuse the situation.

Before going to bed with a cold, it is helpful to take a warm bath and a hot drink. While staying in bed, the diet should be light and plenty of fluid should be taken. The citrus fruit drinks have won their deserved popularity largely as a result of the vitamin C they provide; this vitamin has certain non-specific antitoxic properties.

As a rule, it is well to try to sleep as much as possible while staying in bed with a cold. Reading should be limited whenever the eyes are inflamed.

No medication should be taken internally or used in the nose except upon medical advice.

Medical Treatment for Colds.

Many people before going to bed for a cold wisely go to their physician for treatment. At the start, treatment may result in shortening the cold and often makes it less uncomfortable.

Among the forms of treatment that are in common use are "drops" in the nose, rays of several sorts, and medicines for internal use. In a given case, the treatment will vary according to the person and condition treated.

Medical care is essential if the temperature is high or rising; if headache is severe; if the throat or chest are at all sore; if there is a cough; if there is "stuffiness" or pain in the ears, or hearing is

Sinus Disease.

In almost all colds some of the sinuses are involved to some degree. Infection may take place by extension, but probably it often occurs as a result of forcing infective material into them by too violent blowing of the nose, with both nostrils closed. Occasionally sinus infection follows the forcing of water and bacteria into them by diving while a nasal infection is present, or by using a nasal syringe or spray as treatment for a cold.

The pain that occurs in a sinus is usually due to swelling and closure of its outlet, with retention of mucus and pus. Or the outlet may be open, but the material be too thick to drain freely. Occasionally sinus pain is due not to secretion but to a vacuum within the sinus.

A sinus infection should receive medical attention as soon as it appears, or it may become so firmly established that cure is difficult, or perhaps may advance to a stage requiring surgical treatment.

The Pharynx.

The pharynx or throat is a cone-shaped, vertically placed cavity into which the nasal chambers and the mouth open at right angles. The part of the pharynx that is above the level of the soft palate, and into which the nasal chambers open, is called the nasopharynx; the part at the back of the mouth, the oropharynx. Below, the pharynx leads into the larynx and the trachea.

The throat is subject to many varieties of infection, called pharyngitis, or simply sore throat. Certain infections of the pharynx bear special names, for example diphtheria and septic sore throat. Both of these are serious. They were discussed in Chapter 7, among the specific communicable diseases.

The less serious forms of pharyngitis usually occur as part of the general upper respiratory infection called a cold. The pharynx will appear red and swollen, but will usually not show "spots." Any white spots or membrane on the walls of the pharynx should be investigated.

Gargling with hot salted water often relieves some of the discomfort of a sore throat, and possibly increases the local resistance. No antiseptic gargle can be counted upon to destroy bacteria, however. If local treatment appears to be needed, it should be secured from a physician.

The Nasopharynx: Adenoids.

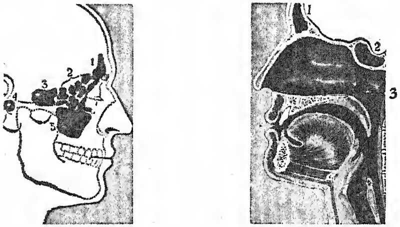
The nasopharynx is behind and above the soft palate. The soft palate is the backward continuation of the membranes covering the

Just as is now the case in regard to spitting on the sidewalk, so also will unguarded coughing and sneezing undoubtedly be eventually a statutory offense. With many people today it has already become a social offense they refuse to pardon.

OTHER RESPIRATORY DISORDERS

The Sinuses.

The accessory nasal sinuses are: the two *maxillary* sinuses in the cheek bones (the right and left antrum): the *ethmoid* cells, back of the nose at its upper part; the *sphenoid* sinuses, in the sphenoid bone



1. Frontal sinus
2. Ethmoidal cells
3. Sphenoidal sinus
4. Middle ear
5. Maxillary sinus

1. Frontal sinus
2. Sphenoidal sinus
3. Orifice of the eustachian tube

Fig. 122.—The Sinuses. (Denver Chemical Company.)

at the base of the brain, behind the upper part of the nose; and the *frontal* sinuses, in the frontal bones in the lower part of the forehead. (See Fig. 122.)

The sinuses serve the purpose of decreasing the weight of the bones; but their main function is that of providing still more space through which the incoming air may circulate and be warmed and moistened. Their lining is continuous with the lining of the nose. The resonance of the voice depends to some extent upon their size and condition.

At birth the sinuses are filled with material which normally is gradually expelled in two to five weeks. A tendency to sinus disease may arise in infancy if the sinuses do not clear promptly, and the tendency may persist through life.

Sinus Disease.

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The Nasopharynx: Adenoids.

The nasopharynx is behind and above the soft palate. The soft palate is the backward continuation of the membranes covering the

hard palate, or roof of the mouth, and it terminates in a small pendulous bit of tissue called the uvula. When swallowing takes place the soft palate is pushed backward and upward, so that food shall not go up into the nose.

Above and behind the soft palate, at each side of the throat is the opening of the tube to the middle ear (the auditory tube). These tubes are closed in ordinary breathing and open when swallowing or yawning takes place, at which time air enters the tubes, which is essential for the function of the middle ear. During infection of the nose or throat the opening to these tubes may be swollen shut, which gives rise to ear symptoms (e.g., the sensation of "talking into a barrel"). If such symptoms do not subside quickly, they should receive attention.

In the nasopharynx, behind the soft palate, is located a small mass of lymphoid, or adenoid, tissue. Overgrowth of this tissue often occurs in childhood, constituting what is known as "adenoids." At times adenoids overgrow to such an extent as to block the passage from nose to throat and to necessitate breathing through the mouth. Also, they may block the openings of the tubes to the ears. The ultimate result of adenoids in children may be malformation of the facial bones, malocclusion of the teeth, and deafness. Since adenoids are often, if not always, chronically infected, they often require removal on that account as well as because of their size.

The Tonsils.

At the sides of the oropharynx are the tonsils, which may usually be seen when the mouth is opened widely. They are normal structures, somewhat similar to lymph nodes. Their function is to take up harmful material, especially bacteria, from the throat and other areas draining into them, and to destroy it.

Infected tonsils harbor bacteria that not only may cause repeated local trouble in the throat, but that may also infect the glands of the neck, causing enlargement and perhaps pus-formation requiring surgical treatment and leaving scars. Also, bacteria or toxins from tonsils may migrate to remote parts of the body and cause trouble. The tonsils are often suspected of being the foci of infection elsewhere, and are usually removed when it is certain that they themselves are infected, or when the glands are persistently swollen.

Tonsils may be enlarged without being infected, in which case their removal is necessary only if they are so enlarged that they obstruct the throat.

When removal is necessary, every particle of tonsil tissue must be removed or the trouble may continue or recur. Therefore the operation should be done by a surgeon especially skilled in throat operations.

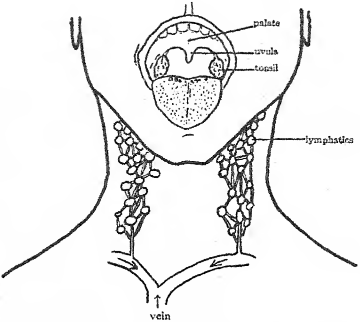


FIG. 123.—The tonsils and the lymphatics associated with them; to show the route of absorption of infective material or bacterial toxins into the circulation.

The Larynx and Voice.

The larynx, at the lower part of the throat and the upper end of the trachea, is a cartilaginous box-like structure for voice production. In men it is often conspicuous as the "Adam's apple."

Stretching across the larynx are two folds of connective tissue called the vocal cords. When small muscles connected with them contract, the vocal cords are drawn taut. Then when the outgoing air passes through them they vibrate and produce sound. The sound is modified by vibrations set up at the same time in adjacent parts.

The *volume* of the voice depends upon the amount of air passing through the larynx from the lungs, and its control. A good voice entails a well developed chest, uncramped by poor posture, and good control over the muscles that expand and contract the lungs.

The *pitch* of the voice depends upon the length and tenseness of the vocal cords. (See Fig. 124.) Women usually have voices of higher pitch than men because their vocal cords are shorter. Reflex action of the muscles that increase the tension of the vocal cords often occurs in emotional states in those lacking poise, in which case the voice is higher in pitch, and more shrill.

The *quality* of the voice is a matter of resonance. The bony structures of the chest, neck and head act as sounding boards that

vibrate during vocalization. The cavities of the throat, mouth, nose and sinuses act as resonance chambers. The membranous structures against which the air current strikes also vibrate and modify the quality of the voice. Obviously, any obstruction of the resonance chambers or any thickening of the soft structures will have a "dampening" effect upon the voice. The voice acquires a flat quality when the upper respiratory membranes are swollen and thickened during colds and chronic infections, especially of the sinuses. Enlarged tonsils and adenoids may have the same effect. In some cases, the voice lacks resonance merely because of faulty

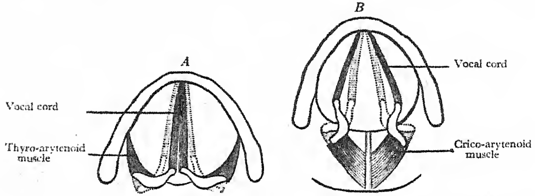


FIG. 124.—Relative position of vocal cords and their cartilages when tense and relaxed. *A*. Vocal cords together and tense, by contraction of thyro-arytenoid muscles. *B*. Vocal cords separated and relaxed, by action of crico-arytenoid muscles. (After Coakley.)

technique in directing the current of sound toward the resonance chambers.

Articulation depends upon the lips, tongue and teeth. The shape of the mouth and the placement of the teeth have an important effect on articulation, but for most people a clear articulation is only a matter of practice.

Skilful technique in the use of the voice is largely a matter of muscular control. The muscles of the chest and neck and of the larynx itself must be managed so as to regulate the exit of air—the rate of outflow and its direction upward. An erect posture favors volume and quality of voice. The position of the neck is of special importance. The head should be held erect by the use of the muscles at the back, so as to give perfect freedom for the use of those at the front that move the larynx up and down in vocalization.

Speech defects (except those that are matters of defective articulation) are most often psychological in origin. This is commonly the case in regard to stammering and stuttering. A mental

hygienist may be of assistance in overcoming the state of mind that interferes with smooth utterance.

Laryngitis.

Inflammation of the larynx is a common accompaniment of upper respiratory infection that spreads downward. As the vocal cords swell when inflamed, they lose part of their ability to vibrate, and hoarseness or perhaps complete loss of voice is the result. Such infections are not usually serious in adults but in infants they may greatly interfere with breathing, causing the symptom known as "croup."

More serious causes of laryngitis are syphilis, tuberculosis and cancer. Any hoarseness not definitely related to a "cold" or other obvious cause should be investigated.

The larynx and vocal cords may also be inflamed by irritants in the atmosphere, possibly by tobacco smoke, especially when the smoke is inhaled. The cords are also sensitive to changes in atmospheric temperature and humidity; either too great dryness with heat or too great dampness with cold may cause them to swell.

Dr. Chevalier Jackson, a leading laryngologist, warns against overuse and strain of the voice in shouting, as at a football game. He says that it may cause hemorrhages which develop into nodules that may have to be removed. However, there is less danger of hurting the vocal cords by use of the voice if the voice is used correctly. Lacking the proper vocal technique, the voice may weary and become hoarse, and the vocal cords be damaged, even by ordinary talking.

Whatever precautions are ordinarily taken to protect the voice, they are of the utmost importance whenever the larynx is already inflamed from any cause. At such times, when the voice is even slightly hoarse, it should not be used at all, or the vocal cords may remain permanently thickened and made susceptible to infection, and the voice be permanently coarsened.

Bronchitis.

Bronchitis is the infection commonly described as a "chest cold." It usually results from the downward extension of infection from the upper parts of the respiratory tract, but it may originate in the bronchial tubes.

Bronchitis begins with a sense of "tightness" under the breast bone, with a cough and perhaps slightly wheezy expirations. The cough is at first dry, but later it becomes "loose"—that is, it is accompanied by the raising of mucus and pus. In children and

females, material from the bronchial tubes is not usually expectorated, but passes upward to the trachea and then downward into the esophagus.

Any bronchial cold should be taken seriously, because the infection is dangerously near to the lung tissue and may lead to pneumonia. Bronchitis itself is sometimes a fatal disease. Even a mild bronchitis may, however, persist if not properly treated, and cause a disagreeable cough, perhaps for weeks. Chronic bronchitis is usually secondary to some other condition (e.g., asthma), or is not bronchitis but tuberculosis.

"Catarrh."

The term catarrh is in popular use by laymen to describe an excess of thick secretion from the air passages. It describes a symptom and not a disease. As has been shown, a catarrhal secretion may come from any part of the respiratory tract. Since such a secretion nearly always indicates infection or some other form of disease, it should be investigated. Patent medicines for "catarrh" have a wide sale. To attempt home treatment of any sort is as unwise as it is futile. Many catarrhal conditions are curable by scientific treatment.

Chapter 29

MUSCULAR EXERCISE

Purpose of Exercise.

In ancient days, daily physical exertion was essential for survival. Man's animal food flew in the air, perched in trees, swam in rivers, lakes and oceans, stalked the underbrush, scurried through field and forest, and hid in caves and holes in the ground. Most of his vegetable food grew at the level of his feet or under the ground or high above his head. Practically all of his environment was potentially hostile and a challenge to his muscular prowess. Nowadays, the only muscular effort for food may be merely seating one's self in a chair at the dining table and rising from it. And the only physical antagonists may be the crowds in the subways.

Yet man retains a muscular system capable of being used for the most strenuous efforts for survival, and if an individual does not use his muscles for such purposes he must perform some substitute activities to keep the muscles in health and to cause the physiological effects produced by muscle work. These substitute activities are known as exercise. Under the heading of exercise may also be included the deliberate muscle training taken to prepare the muscles for greater exertion whether of work or play, and to improve physiological function.

Physiological Classification of Exercise.

Exercise may be classified in a number of ways (e.g., general, of the whole body, or local, of part of the body; formal, motions made for the sake of the exercise itself, or incidental, motions occurring during work or sport; indoor or outdoor; regular or sporadic; etc.), but physiologically the primary classification of exercise concerns the *amount of energy* expended in it, which may be stated in terms of calories or of foot-pounds. Such computations are the basis of classification of exercise into light, moderate and heavy. Light and moderate exercise are of a sort that can be kept up by a normal person for long periods without physiological embarrassment; heavy exercise is that which can be performed only by a vigorous person and can be kept up even by him for a short time only.

It is to be understood that the terms light, moderate and heavy have reference to the ability of average normal adults. Obviously, light exercise for a trained athlete would be heavy exercise for a young child or an old person or anyone in feeble health, for many women, and indeed for many men of sedentary habits.

Physiological Effects of Exercise.

In all exercise of the muscles, certain physiological changes take place, the degree of change depending upon the amount and severity of the exercise. In heavy exercise very marked changes take place throughout the whole body, but especially in two systems, the circulatory and the respiratory. These will be described in the following paragraphs. The effects to be mentioned are those that would be experienced by a well person using his maximum effort. In the case of a person not in good health or not in good training the effects of using his own maximum effort might be the same to a lesser degree, or they might be quite different; he might indeed collapse before the physiological adjustments to be mentioned were made.

Circulatory Changes.

The more active the body is, the more oxygen the muscles require to support combustion. Therefore, during exercise the heart increases its action in order to send more blood to the lungs to take up oxygen and to the muscles to deliver oxygen, and other changes, as noted below, take place to meet the needs of active cells.

The *stroke volume* of the heart increases—that is, the volume of blood sent out from the heart at each contraction. Normally the heart has a stroke volume of about 60–70 cubic centimeters of blood; during vigorous exercise this may increase to 200 cubic centimeters.

The *rate* of the heart is increased, often to more than double its normal rate; it may increase from 70 beats per minute to 150 or even more.

The *total volume of blood* in circulation in the body increases, by discharge of an extra supply of blood from the spleen; the increase may raise the total amount of blood from 6 liters at rest to 7 liters during exercise.

As a result of these changes, the *total cardiac output* per minute is greatly increased. Whereas the heart at rest may have an output of 3 or 4 liters of blood per minute, during exercise its output may be 20 or 30 liters. The latter amount, 30 liters per minute, is the highest cardiac output that can be reached by the human breathing

air. It will permit exercise to the extent of one half hour's running at the rate of 9 miles per hour.

The *pressure* of blood in the arteries increases, perhaps to 50% more than its resting rate, or even higher.

Many extra *red cells* are turned into the blood as vehicles for carrying oxygen. Tests made on lifeguards at a beach in Florida showed that after swimming 45 minutes in water at 68.5° F. their

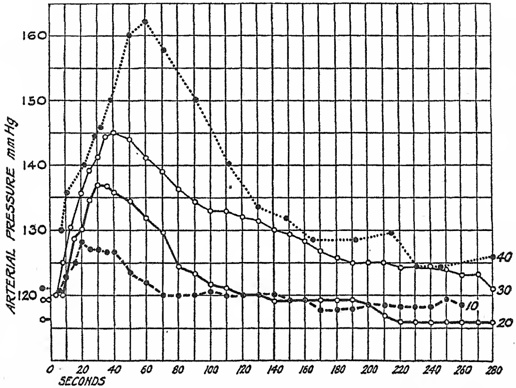


Fig. 125.—Systolic blood pressure readings (vertical column) taken every 20 seconds (horizontal column) following a period of exercise (lifting 20-lb. dumb-bells once in two seconds the number of times indicated by figures at right) completed before the first reading. In more strenuous exercise, rise of blood pressure would occur during the exercise. (Winton and Bayliss.)

blood showed an average increase of more than a million red cells per cubic millimeter. The white cell count was similarly increased.

The distribution of blood throughout the body changes during exercise; a relatively larger proportion is furnished to the organs that are most active. The skeletal muscles, the heart muscle and the lungs become *hyperemic*. The skeletal muscles may receive 18 times the amount they receive during rest. At the same time, the organs not directly concerned in the activity receive less blood. At first the skin is deprived of some of its blood, and looks pale, but as exercise proceeds, and the need for loss of heat increases, more blood goes to the skin and it becomes flushed.

The capillaries in the muscles become *dilated* so as to hold more blood. This has the effect of delaying the passage of blood through muscle tissue, which allows time for the tissues to take a full supply of oxygen from the blood and to give off their waste into the blood. The *linear velocity* of blood through capillaries may be decreased to half its usual rate.

Also, many small capillaries through which blood does not ordinarily pass become *patent*. The number of permeable capillaries per square millimeter may increase from 200 at rest to 2500 during exercise.

The *return of venous blood* to the heart is increased, because of the increased pressure of muscles against veins, the increased depth of breathing, and the rise of pressure in capillaries. In spite of the decreased linear velocity through capillaries, the onward progress of blood through an active muscle is more rapid than through an inactive one.

Obviously, the entire circulatory system during exercise becomes coordinated to one end—that of increasing the supply of oxygen to active muscles. Yet the facilities for carrying more oxygen would be futile if more oxygen were not available through increased lung action.

Respiratory Changes.

Pulmonary ventilation increases, in order to take in enough oxygen to support increased action of the muscles. The *rate* of breathing may increase from a resting rate of 18 breaths per minute up to 30–40 or more. Also, the *depth* of breathing increases; all the chest muscles are utilized, and the excursion of the diaphragm is increased. Breathing may take place through the mouth, and the muscles in the wings of the nose may be contracted so as to open the nostrils as widely as possible.

As work becomes more and more severe, *lung ventilation* is increased in direct proportion; it may rise from a resting intake of 5 to 8 liters of air per minute to an exercising intake of 50 to 100 liters.

During rest, the blood that comes from the tissues and goes to the lungs for oxygen usually contains 14 cubic centimeters per cent of oxygen, and is capable of taking up an additional 5 cubic centimeters; but during exercise it may contain as little as 3 to 7 cubic centimeters per cent, and be capable of taking up 12 to 16 cubic centimeters. It has already been shown that an increased volume of blood goes to the lungs during exercise. As a result of these two factors—volume and composition of the blood—increased breathing

during exercise is effective in greatly increasing the oxygen taken up by the blood. Circulatory and respiratory changes combined make possible an increase in the intake of oxygen from a resting level of about 0.25 liters per minute to 4.0 liters per minute (approximately one gallon) as a maximum.

Furthermore, as has been shown, oxygen is better distributed to tissues during exercise, and is more fully utilized by them. If the system takes in 16 times as much oxygen as usual, the active tissues may have available many times that amount.

Heavy exercise is made possible because of the adjustments mentioned, but even they are not enough; the person who is exercising heavily does not succeed in meeting his oxygen need, and he incurs an "oxygen debt."

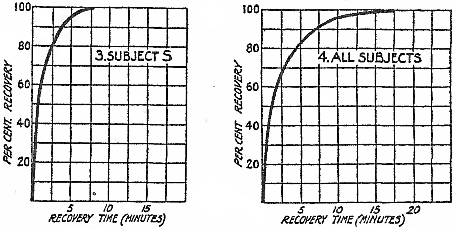


FIG. 126.—The rate of recovery from a short spell of severe exercise (standing-running 30–60 seconds). Subject S was an athletic student. Per cent of recovery is measured by per cent of oxygen debt paid off. (Winton and Bayliss.)

Oxygen Debt.

In a short but very vigorous act such as a 100-yard sprint it is not possible to take in enough oxygen to meet the requirements of the muscles. As a matter of fact most sprinters do not even try to do so, but hold their breath during the act. For such a sprint the oxygen requirement may be over 6 liters, whereas the maximum intake for ten seconds would be 0.66 liters. The sprinter makes up the deficit of 5.33 liters by breathing harder after the exercise is over. This is possible because, when necessary, the muscles can contract for a time even though the circulatory system does not furnish them enough oxygen, the energy for such contraction being derived from substances in the muscles themselves (oxygen in the hemoglobin of the muscles, and certain substances that break down and yield energy in the absence of oxygen, i.e., anerobically). But when

contraction takes place without a concurrent intake of sufficient oxygen an oxygen debt is incurred—that is, oxygen is owed to the tissues, and must be repaid at the earliest moment. It is possible to perform for short periods an amount of work that would be impossible if the muscles were like a gasoline engine in being dependent upon a constant inflow of sufficient oxygen delivered at the same time as the fuel.

The maximum amount of oxygen debt which a human can incur is 18 liters, as determined by measuring the amount of oxygen used during the recovery period and comparing that with the amount used at rest for the same length of time.

The average person can not keep free of oxygen debt unless the oxygen requirement for the activity in which he is engaging is less than 2 liters per minute. At that level of oxygen consumption, or below it, the body "pays as it goes," furnishing enough oxygen for the uses of the muscles and for the reconstruction and disposal of lactic acid.

Recovery.

While repaying a heavy oxygen debt, the individual is likely to look bluish, indicating that the blood is short of oxygen, and to be "out of breath" for a time. For example, a trained athlete who ran 225 yards in 25 seconds breathed more rapidly than at rest for 48 minutes.

The more rapid breathing during exertion is a reflex due partly to the increased tension of carbon dioxide in the blood and partly to the effect of carbon dioxide and lactic acid in rendering the blood less alkaline than usual. These two acids are produced during exercise and as they circulate in the blood they act as a stimulus to the breathing center. After exercise is concluded breathing continues to be rapid because of the continued presence of carbon dioxide and lactic acid.

In moderate exertion, lactic acid is disposed of as fast as it forms, but in extreme exertion it is formed in large amounts and is passed out of the active muscles into the blood stream. The level of lactate in the blood, which during rest may be 10 to 20 milligrams per 100 cubic centimeters, may rise during exercise to 100 milligrams. Much of this lactic acid is resynthesized into glycogen in the liver, heart and elsewhere, or is used in combustion, but some of it passes out of the system through the perspiration and the urine. While it is present it accounts for some of the uncomfortable feeling of fatigue.

Much of the carbonic acid is utilized in the body for the reconstruction of the bicarbonate in the blood, which has been broken down during exercise by the action of lactic acid; the excess is largely blown off through the lungs.

$$\begin{array}{ccccc} & \text{Lactic acid} & \longleftarrow\!\!\!-\!\!\!-\!\!\!-\!\!\!-\!\!\!-\!\!\!- & \text{Lactic acid} & \\ \text{Events} & \downarrow & & \uparrow & \text{Events} \\ \text{in} & \text{Glycogen} & & \text{Glycogen} & \text{in} \\ \text{liver} & \downarrow & & \uparrow & \text{muscle} \\ & \text{Glucose} & -\!\!\!-\!\!\!-\!\!\!-\!\!\!-\!\!\!-\!\!\!\longrightarrow & \text{Glucose} & \end{array}$$

FIG. 127.—The cycle of events to make energy available.

The excess of oxygen taken in during the period of recovery has also served to dispose of the various other products of metabolism (metabolites) that have accumulated while activity was in progress. Some of these, which would be much more injurious than lactic acid, are disposed of first of all.

Ultimately, after the blood has been restored to its normal alkalinity, and carbon dioxide tension has become normal, the rate and depth of respiration return to normal, by which time the pulse and blood pressure have also resumed their normal rate.

Breathlessness.

It will be seen that becoming out of breath is a normal result of oxygen debt. Ordinarily one does not become aware of increased breathing until the air intake has doubled, nor become uncomfortable until the rate has become four or five times the normal.

One of the important factors that determine how hard a person has to breathe after exercise is the vital capacity of the lungs, or the amount of air they can take in and give out per breath. Obviously, a *low vital capacity* causes early breathlessness upon exertion. Among other factors is *lack of mechanical training* in the exercise in question; the untrained person uses more energy in the same task than the trained person, and incurs a greater oxygen debt. In older persons, and in some younger persons who are delicate, a *diminished efficiency of the chest muscles*, with relative immobility of the ribs, hampers the taking in of increased quantities of air per breath. In those with *anemia*, the difficulty is that there are not enough red blood cells, or not enough hemoglobin in each, nor in the muscle cells themselves, to take in enough oxygen to support even light exercise. Certain *chemical conditions* in the body (e.g., certain poisons, including alcohol and one or two medicines) interfere with due intake of oxygen. Finally, any *weakness of the heart* prevents its increasing its stroke volume, which is fundamental in the adaptation to increased work.

The fitness of an individual for any given form of exercise can be gauged by the oxygen debt he incurs in measured test exercise (e.g., running in place) and the time it takes for his breathing, as well as his pulse and his blood pressure, to return to normal.

Power Generated during Exercise.

When muscle is in action it generates a large amount of energy; for example, in a 100-yard sprint 13 horsepower of energy is generated. But as with engines, the energy created is not all used in work; some of it is heat. The mechanical efficiency of an engine is the percentage of energy that is used in work in comparison with the total generated. In this respect highly trained muscle compares favorably with the best gas engine, which generates 65–75% heat and 25–35% work. In the 100-yard sprint, about 3 horsepower of the 13 horsepower generated (i.e., about 23%) are used in work, half of it in flexing and extending the legs, and the other half in overcoming gravity, making arm motions, face motions and sidewise motions that probably contribute indirectly to onward progress.

One of the differences between the trained athlete and the untrained person is that mechanical efficiency is greater in the former. The untrained may generate five or six times as much energy as they can use in work, and the work they do may be proportionately too largely extraneous motions. Nevertheless, even the least trained muscles are more efficient than the ordinary steam engine, which produces 95% heat and only 5% work.

The maximum energy production of humans is perhaps reached in the 100-yard swimming race, which utilizes energy at the rate of 12,000 calories per hour. Sprinting is very near to that level.

For sustained work, the maximum is very much lower—probably 600 calories per hour above the basal level is the maximum. Activities that may reach the maximum are long distance running, such as Marathon races (or even dance Marathons); mountain climbing, of high peaks by expert climbers; channel or other long distance swimming; rowing races, which may go beyond this level near the finish; and wood chopping in a forest. Others that may utilize nearly the maximum are wrestling and boxing.

The Athlete's Physiological Status.

As a result of athletic training an athlete differs from a sedentary person in a number of respects. First, the vital capacity of athletes is usually very much higher than of those who have never been muscularly active (except singers). Second, the stroke volume of the heart is greater at rest, and increases to a greater degree during

exercise. This is not because the athlete's heart is enlarged, but because it has greater muscular power.

Because of the efficiency of the heart and the lungs, the pulse rate of the athlete need not be so rapid, either at rest or during exercise, and the blood pressure need not rise so high during exercise. Also, as a result of the cardiac and pulmonary efficiency, the percentage of oxygen in the venous blood does not fall to so low a level during exercise, and the percentage of lactic acid does not

Subject	Work performed. Kg-metres per min.	Oxygen consumption. Litres per min.	Pulse rate per min.	Cardiac output. Litres per min.	Output per beat. c.c.
Untrained female	0	0·24	77	4·6	60
	600	1·57	131	14·5	111
	720	1·79	145	17·4	120
	840	2·05	159	19·0	120
	960	2·45	168	23·8	142
Trained male	0	0·25	70	4·2	60
	720	1·93	118	16·5	140
	960	2·22	140	20·6	147
	1,200	2·83	174	23·0	132
	1,440	3·26	180	26·9	149
	1,680	3·94	179	37·3	208

FIG. 128.—Some of the physiological changes produced by exercise. (Winton and Bayliss.)

rise so high—in fact it may scarcely rise at all during fairly severe exercise.

Clearly, the trained athlete has two major advantages over the sedentary person. First, he has greater physical endurance—the ability to expend a great deal of energy economically, and to withstand fatigue. Second, he has a better circulation of blood, with all that that implies of improved function throughout the body. Under each of these two headings, dozens of specific advantages will occur to the reader.

Exercise for the Non-athlete.

What the athlete gains is of advantage to him in athletic work or any other work that requires great muscular activity; but also it is of advantage to him in everyday life, just as it would be to anybody.

The question arises whether it is necessary to become an athlete in order to obtain similar physiological advantages. It is not; lesser amounts of training will bring the average person a satisfactory ability to withstand fatigue—that is, to do his work easily and to have a margin of endurance and vitality for leisure activities. Also, lesser amounts of exercise serve to give a thoroughly adequate circulation.

In deciding all matters of exercise (kind, amount, etc.), two points are of importance—*suitability* and *training.*

Personal Suitability.

There is no aspect of hygiene that is a more individual matter than exercise. Even those who are well are not alike in the amount and kind of exercise that meets their physiological needs (i.e., improves their endurance, their circulation, and the function of their organs); and those who are not well vary still more widely.

Nearly everyone classified as well will profit by taking exercise suitable for him, but when possible the decision regarding suitability should be made after physical examination by, and consultation with, a physician who is familiar with the various forms of exercise.

Among the factors that enter into the choice of exercise are the following. First, the *type of musculature* itself helps to determine what sort of exercise will be, for the individual, light, moderate or heavy. To a considerable extent the type of musculature is inborn, and cannot be cultivated beyond a certain point. But whatever the possibilities of future development, it is the present status of the muscles that must be considered in planning an exercise program. If greater muscle power is needed and is possible, it will come through gradual training—as every school boy knows.

Second, the *type of skeletal structure* is of importance in choosing exercise. Some individuals are of the closely knit type, in whom there is little lost motion at joints; others, especially the longilineal type, may be so loosely knit that they are liable to joint strain in certain sports.

Third, *age* influences the suitability of exercise. In general, those who are older are unfitted for short *sharp* spurts of exercise, although their endurance may last longer at moderate endeavor than that of younger people. From about forty years onward, the blood vessels are likely to be somewhat stiff and not able to stand the sudden increase in pressure within them such as almost any heavy exercise causes even in those who are well trained. In youth the problem may be that of underdevelopment of the skeletal mus-

cles and the heart. It is thought that in the majority full muscle power is not attained nor attainable until about twenty-five years of age. Certainly a considerable number of those at the age of eighteen or twenty have gained proportionately more in lineal growth than in heart power, and should not attempt maximum efforts without having medical advice. The skeletal system, too, does not attain full development until about twenty-five years of age; the long bones, which are in three sections during the early years of life, do not fuse until the sixteenth to the twenty-fourth year, and the sacrum and hip bones until a year later. Ordinarily this does not handicap a person for exercise within his own range of tolerance, but does require keeping within that range.

Fourth, the matter of *disease* greatly influences the choice of exercise, and this is true of both organic and functional disorders. In some diseases, exercise of the right sort is extremely valuable as treatment. It acts as a general tonic or stimulant in many sorts of ills; and conversely, it may in some cases be useful as a nerve sedative. In any disorder of the body subject to improvement as a result of increased muscle power or increased circulation, exercise may be of specific value as treatment. On the other hand, helpful as exercise may be in some cases, it may be equally harmful in others. Generally speaking, there is some form of exercise that would be suitable and beneficial to most individuals who are able to be "up and around."

Exercise Preferences.

The impulse to activity is not entirely reliable—that is, the desire for activity and the need for it do not always correspond. Many people are impelled toward more exercise than is good for them; and many toward less. This occurs for a number of reasons.

The desire for exercise may be a fictitious one, not a physiological want. For example, a person may believe he really wants to play football, when what he really wants is the athletic prestige. Similarly, a person may "want" to climb mountains, not because he feels like it but to bolster his ego. Or a person may have listened to so much commercialized propaganda of physical culture quacks that he thinks he wants to go through the orgies of exercise they assert will make him "fit." In any such cases as those mentioned, the results might be good—or they might not.

Conversely, after sitting still most of the time for years a person may feel quite averse to exercise and be convinced by his breathlessness and fatigue after exercise, and perhaps his somnolence when

he wants to study, that exercise—any exercise—is harmful to him. Again, such a person may be right—but perhaps not.

It is to be recommended that those who feel no craving for exercise find out whether they are entitled to a completely sedentary life, and that those who crave extraordinary amounts of it make certain that they are entitled to the life of an athlete. It is a simple matter to make sure, and it may make a great difference in health and happiness.

Those who are in the habit of taking light or moderate exercise, and who are not too much fatigued by it at the time or a few hours later or the next day, may usually conclude that they are within their range of safety—although it would do no harm even for them to make sure that their preference is in accord with their needs.

The very first book on physical education was written by the Greek, Herodikos, and entitled "How to Stay Well by the Use of Bodily Exercise." The author had fallen ill with tuberculosis, which he attributed, probably correctly, to overexertion in games, and he wrote his book to advocate moderation.

Training.

The concept of training is a familiar one with respect to heavy athletics; it should be equally familiar with respect to any increase of activity beyond a present level. For example, the desk worker who decides that he needs more exercise should plan a training period in embarking upon golf or tennis or swimming or bowling, or even gardening.

The principle of training rests upon the fact that the body cannot change its entire mode of operation instantly. The heart will not, for example, increase its stroke volume from 60 cubic centimeters of blood to 200 the first time such an increase is demanded of it, but only after its musculature has gradually gained in power.

The matter of gradual training is of particular importance in the case of those who are in any way handicapped, either by the results of previous inactivity or by disease. For those who are no longer in their first youth, it is absolutely imperative that they increase their activity, if at all, gradually and watchfully. It would be preferable for those of middle age to take no exercise at all rather than to increase their exercise to any extent without a due period of training. With some young individuals the same is true.

One of the important features in training is regularity. It is scarcely more feasible to take a week's exercise in one day than to take a week's food in one day. Some persons take little exercise

during the entire year and go on an "exercise spree" during the two weeks of their summer vacation. Even if it does not harm them, the benefit can hardly be expected to last during the year. As someone has said, one cannot get along on last year's exercise any better than on last year's bathing.

"Training down" after a season of great activity in sports is nearly as important as training up. Almost all physiological adjustments are best made gradually. One of the dangers of dropping one's habits of exercise too completely and too suddenly is that a good appetite usually persists, and that eating habits may remain the same while combustion habits are greatly reduced. The former athlete often puts on weight and some of the fat may be deposited in and around the heart. Defective heart action in such a person is sometimes wrongly attributed to exercise when it is really due to faulty methods of training down.

Development of Physical Education.

Systematically planned bodily exercise for the purpose of keeping fit is probably as old as civilization itself. Fitness for its own sake, apart from its utility for military purposes or as an aid to general health, seems to have appealed to early man. It is said that the Northmen cultivated the body and that their heroes were "as beautiful as strong." The same impetus to physical development seems to have influenced primitive peoples in all countries. But it was in Greece that exercise first became of fundamental and national importance—even of religious significance. The Greeks of classical times had an ideal of physical perfection, and to that end they developed gymnastics. The term gymnastics means "the naked art." It was the young men trained in this art who became the perfect specimens portrayed in the sculpture of Phidias.

At first gymnasiums were entirely for physical education. All the boys of the free-born were sent to them from the age of seven until they were ready for full citizenship and military duty.

These first of all schools later widened their curriculum; in addition to physical education the youth were taught politics, literature, science and art. But the primary purpose of the gymnasium never changed. Leaders such as Aristotle and Plato recognized physical training as the most important aspect of the training of youth. It was conducted under the supervision and the regulation of the state, according to laws established by the great law makers Lycurgus of Sparta and Solon of Athens. In each gymnasium, the work each youth did was directed by both trainers and physicians.

The great physician of ancient Greece, Hippocrates, recognized that exercise is important not only for prevention but for the cure of disease. He called the scientific use of gymnastics *iatroleptica* (*iatro*, treatment; *leptica*, to oil the skin), the name being derived from the custom of anointing the skin prior to exercise.

Sports, too, began in antiquity. Frescoes from ancient Egypt show that dancing was popular, and apparently some of the games that persist to this day as children's games (e.g., hide and seek, and prisoner's base). It was Greece, however, that brought sports into an important place in national and individual life. Nearly every free-born Greek was an amateur athlete. Four national annual athletic contests were held, of which the Olympic games, held from 776 B.C. to 339 A.D., are the most famous. These festivals of games were all pentathlons, or contests in which each participant took part in five sports, as follows: *running* (with and without armor, and for varying distances, including the long distances now known as Marathon races); *jumping* or leaping, for distance only; *discus throwing; spear throwing;* and *wrestling*.

Toward the end of the Hellenic supremacy, sports became professionalized; the average citizen was content to watch others play rather than play himself. Some believe that the general loss of fitness had a bearing on the decline of Greece.

Rome at its zenith also stressed both physical education and sports. During the first century A.D. gymnastics were recognized as "the most important branch of the science of medicine." At the time of Rome's decline, the heavy sports such as wrestling and boxing were largely engaged in by professionals, and only the lighter sports by amateurs.

For centuries after the fall of Greece and Rome, little was heard of sport for sport's sake and still less of physical education. Although the theory never lapsed, the practice of it did, except among the knights who kept themselves in condition for warfare.

In modern times, interest in physical education dates back about 150 years, to the publication of a book in Germany in 1793 on gymnastics for children. The author states that "gymnastics is work disguised in the garb of youthful joy." Shortly thereafter there sprang up in Germany a number of "turnplätze" or gymnastic places, modelled after the Greek gymnasia, for physical and mental education.

The greatest development of gymnastics, however, took place in Denmark, where it was introduced into the public schools in 1814, and in Sweden. Both Danish and Swedish gymnastics were later

introduced into this country. It was in the United States, however, that the most extensive growth of sports for the general public took place.

In recent years there has been a revival of the Greek interest in national fitness through physical education. A number of countries have established extensive programs for the betterment of national health through exercise. In many lands since 1930 public health interest has centered especially on three matters—nutrition, housing and physical education.

Chapter 30

FATIGUE AND REST

Physiological Fatigue.

Fatigue may be defined as a physiological state that is produced by activity, that limits the quantity, and usually the quality, of further work, and that usually produces a feeling of fatigue that takes away the desire for further work.

It is not desirable to try to prevent all fatigue, for fatigue is both normal and necessary, within limits. Normal cells do better for being regularly worked and regularly fatigued, and as regularly rested and restored. Power, both mental and physical, comes through effort sufficient to cause a normal degree of fatigue.

Pathological Fatigue.

Abnormal fatigue is as harmful as normal fatigue is beneficial. To live long and well, overfatigue must be guarded against as carefully as any other cause of disease.

Pathological fatigue may be *acute*, such as follows unusually severe activity, or activity at high speed or of long duration. Permanent impairment of health may result from a single bout of overexertion and overfatigue in the case of those who are not in the best of condition. Also, fatigue may be *chronic*, the result of continued exertion beyond one's limits.

Changes Due to Fatigue.

When the body works, glycogen is burned and metabolites (lactic acid, carbonic acid and other substances) are produced from the fuel burned and from katabolic changes in cells. Cessation of working power could theoretically occur either from lack of further supplies of glycogen, or from a hampering effect of metabolites upon cell activity, or from oxygen shortage, or from structural changes in cells. It is probable that all these factors usually enter into fatigue, in varying degree.

Metabolites.

In ordinary fatigue, the presence of an excess of metabolites causes irritation of sensory nerve endings in working parts (giving

the feeling of fatigue), and interference with the transfer of nerve impulses to muscles (as shown by the fact that a muscle can be made to contract after it has ceased to respond to nerve impulses). Usually these effects of metabolites cause work to stop before the other three factors become of importance. Fatigue metabolites are sometimes called fatigue toxins, owing to the poisonous effect they exert while present in excess.

In activity of a small part of the body, metabolites may be produced locally and give only *local* fatigue. *General* fatigue is due either to general activity or to flooding of the whole body with metabolites from overworked parts.

Metabolites of fatigue are recoverable from the blood of a fatigued animal. If a dog is exercised to the point of excessive fa-

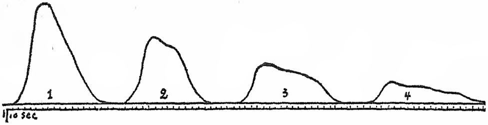


Fig. 129.—Fatigue of muscle. A gastrocnemius muscle of the frog stimulated successively 150 times. The 1st, 50th, 100th, and 150th contractions are recorded. (From Burton-Opitz "Elementary Manual of Physiology." Courtesy W. B. Saunders Co.)

tigue, and some of his blood is withdrawn and injected into a dog that has been resting, the rested dog shows every evidence of great fatigue and a desire for repose.

Cellular Changes.

Overexertion may damage overworked cells. It is thought that in pronounced fatigue there is some degree of cell impairment throughout the body, although this is usually only temporary unless fatigue is too great in amount and too often repeated. The tissues most conspicuously damaged are the cell bodies of the nerves that supply the acting muscles with impulses. In the carrier pigeon after a long flight, the nerve cell bodies become smaller and their nuclei do not appear as solid as usual; minute stainable bodies in them, called Nissl bodies, become less conspicuous. Since it is thought that these Nissl bodies may be the source of nerve cell activity, obviously this process of chromatolysis (dissolving of colored substance) would be detrimental to further work.

Recovery from Fatigue.

The body has the power to recuperate from ordinary fatigue; only that which is excessive and prolonged or cumulative leads to

permanent damage. After a due amount of rest the products of fatigue are either reconstructed into glycogen or are excreted, and the cells regain their usual state. The sensory nerves are no longer so stimulated as to have the sensation of fatigue. A renewed desire for activity appears.

The Feeling of Fatigue.

When the *state* of fatigue is present, the *feeling* of fatigue is normally present also. Like hunger and thirst, the feeling of fatigue

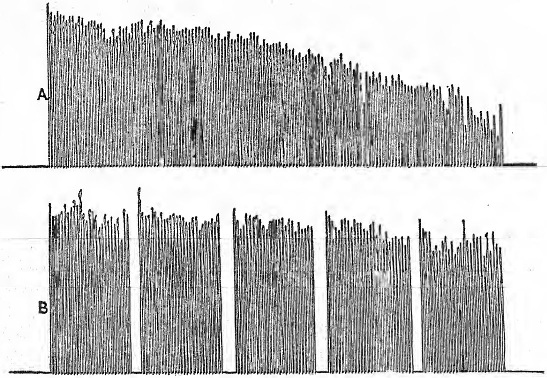


FIG. 130.—Fatigue of voluntary muscle of finger, doing work on an ergograph at the rate of 48 contractions a minute, for 3 minutes. In A the subject worked continuously and did 1.80 kilogramme-meters of work. In B the subject took four rest periods of five seconds each, and did 2.23 kilogramme-meters of work; at the conclusion the finger was contracting nearly as strongly as at the start.

is a protective mechanism which indicates a body need. In general, all these feelings tend to be reliable, but are not invariably so. This is particularly true in regard to the feeling of fatigue; it may not correspond to the state of fatigue. Great weariness may be present after slight exertion and lacking in exhaustion. To avoid overfatigue would be a simple matter if feelings of fatigue could always be accepted at their face value; but such is not the case.

Some of the factors that must be considered in connection with both the state and the feeling of fatigue are discussed in the following paragraphs.

Undue Fatigability.

Tired feelings out of proportion to the work done may be due to disorder in the state of the *body* or in the state of *mind*. A number of conditions may affect either muscles or nerves in such a way as to lower the threshhold of fatigue, so that fatigue appears too readily.

Probably the commonest cause of undue fatigability is *incomplete recovery* from previous fatigue.

Second in order is perhaps *muscle weakness*, due to lack of sufficient use of muscles or to poor nutrition or to both. (In some cases a specific dietary lack, the amino acid glycine, causes an abnormal breakdown of protein substances in muscle, as indicated by excessive excretion of creatinine in the urine, which results in marked fatigability. Glycine is not one of the amino acids classed as essential, since it is normally produced in the body from protein food if not present as such in the diet.)

Third, it is a characteristic of many kinds of *disease* to cause the same tired feelings as work—and not only that, but to make the body especially susceptible to the fatiguing effect of work. Therefore a person who is ill would be likely to feel tired in any case, and to feel disproportionately so if he exerts himself to any extent. Undue fatigability is often a valuable symptom, in that it points to the need for a physical examination.

Fourth, certain attitudes of mind and certain emotional states may cause one to feel fatigue too soon and too intensely.

Infection and Fatigue.

Weariness not due to work is a common result of infection. A person ill with a cold may feel as tired as if he had played six sets of tennis or taken a ten-mile walk, even though he has been doing nothing more strenuous than sitting in classes. It is probable that the bacterial toxins affect the adrenal gland, and reduce the energy supply to such an extent that the slightest exertion is an effort. One who feels profoundly weary after an acute infection that kept him in bed may mistakenly think that his having been in bed was what made him weak, whereas the real explanation is the illness itself.

In chronic infections, too, lassitude is often a prominent symptom. At the onset of tuberculosis, for example, a degree of fatigue out of proportion to the work done may be the first and chief symptom.

Deficient Oxygenation of the Blood.

In a number of abnormal conditions the explanation of the profound and characteristic fatigue is imperfect oxygenation of the blood. This is the case, for example, in *anemia*, in which the red blood cells are too few and lack a due amount of iron, and are thus not able to carry the full quota of oxygen to the tissues, including the nerve centers.

A similar susceptibility to fatigue may occur whenever the circulation is inadequate as in heart disease.

Sedentary Fatigue.

Those who do no muscular work more vigorous than sitting at work at a desk or sitting at the wheel of a car may experience fatigue from the cause just mentioned—imperfect oxygenation of the blood. While making no large motions, they are using many muscles to keep themselves stationary. They produce metabolites, but do not activate the circulation enough to cause an increased intake of oxygen; therefore the metabolites remain in the tissues, causing discomfort. In such circumstances the impulse to "stretch" or to move about may automatically relieve the situation.

Other factors may be involved, however, when those leading quiet lives are especially subject to fatigue; such should be suspected if a judicious amount of activity proves more fatiguing.

Those who live sedentary lives not offset by daily exercise, and who are chronically fatigued, often find that if they try to cure their fatigue by rest, it increases. Unless circumstances force them to move about, they may go from bad to worse without ever learning what would, for them, be a cure for "that tired feeling."

Nervous Fatigue.

This term is often applied by the layman to any fatigue not accounted for on the grounds of physical exertion or illness, and which involves "nervousness" in the popular sense. It appears that such fatigue is often ordinary *overfatigue* in a person of no great endurance and taxing endurance too far; or ordinary fatigue made more marked by some sort of *illness;* or fatigue produced as a *reflex* from an organ that is out of order (e.g. general nervous fatigue as a result of eye strain). However, nervous fatigue may be based upon an *emotional attitude* of some sort, particularly one that creates motor tensions. The latter type is extremely common. Perhaps it enters into all fatigue to some extent, but in some cases dominates the picture.

Mental States and Fatigue.

It is readily observable that emotions sometimes produce profound physical effects. For example, fear may cause trembling of the muscles, dry mouth, increased peristalsis; and anger may produce muscular tension and all the physiological changes necessary to equip one for a fight. Either of these two emotions, and many others, may influence the actual amount of fatigue, or the awareness of fatigue. It is often the unsuspected effect of emotional factors that makes it difficult to gauge the actual amount of fatigue that is present. Also, it is often emotional factors that lead to under- or over-use of one's powers.

Interest.

One who is intensely interested in what he is doing may fail to appreciate fatigue when it is present. His keen interest may stimulate him so much that he scarcely knows he is working hard, and would hardly admit fatigue. In fact, he may actually not be as fatigued as the same work would make him under ordinary circumstances. It is doubtful whether Marathon runners could run 25 miles and feel as fresh as they often do at the end of the race if it were not for the thrill the whole performance gives them.

In circumstances that provide incentive to work hard, not only is less fatigue felt but actually less is present. This is because of the increased amount of *adrenin* from the adrenal glands, whereby more glycogen is made available and various other changes made, whereby the muscles receive more oxygen and the acids of fatigue are more rapidly disposed of. The element of competition in a task (with others, with one's own record, or with time) makes it actually less "tiresome."

Boredom.

Just as intense *pleasurable interest* reduces both fatigue and the perception of it, so also does *lack of interest* make a task harder and more wearisome. This is common in those who are trying to do work beyond their capacity; or work for which they have not been properly prepared; or work whose significance means little to them.

In general, familiarity with the material (mental or physical) with which one works breeds not contempt but interest. If a task is obligatory it behooves the worker to find something interesting in it, or be bored and fatigued by it. The interests of most successful adults are acquired ones.

Anxiety.

Although pleasurable interest decreases the sense of fatigue, *anxious interest* increases it. Traced to its lair, worry often turns out to be lack of sportsmanship—a lack of willingness to play one's best cards and abide by the consequences. Sometimes it seems that the "worrier" is not gifted with enough of the spirit of adventure, and that the lack makes him a craven, fearsome coward in the face of any emergency that might go against him. When confronted by the new—new conditions of environment, new social problems, new people, new working conditions—the need for adaptation is oppressive to those whose adaptive powers have not had enough practice, and their reluctance to meet these adventures half way may be interpreted by them as fatigue. Sometimes this is the case in those who feel that they must drop out of college.

Suggestion.

Feelings of fatigue are in a sense almost as "catching" as germ diseases. In a college group sometimes an epidemic of fatigue can be traced to one person who complains to everyone he meets of the "terrific strain" he, and all the others, are under, and how tired they all ought to be. However, a good many people are more stimulated than otherwise by the idea that a task is hard.

The suggestion of fatigue often arises when there is something more pleasant to do than work. All at once one may feel quite too tired to do the unpleasant thing. In no field is it more important to face facts squarely than in the estimation of the amount of fatigue. Without perfect willingness to face and admit facts, one is more or less at the mercy of subjective feelings due to "wishful thinking."

It should not be necessary to mention that no one should ever casually comment to another that he "looks tired." Even a person of great strength of character is likely to feel fatigued if he is told he looks so.

Fear of Overwork.

The fear of overwork and of overfatigue haunts many people continuously, and is partly responsible for whatever fatigue feelings they experience. Generally they could and should be much more carefree about the matter.

For the sake of those who really would like to work hard but are afraid of using their capacities to the full, the following words of William James may be quoted.

"Most of us get into the habit of living on *too inefficient a plane*, and could increase our output largely without taxing our organism to the danger point. Of course there are limits, the trees do not grow to the sky. But the plain fact remains that men the world over possess amounts of resource which only very exceptional individuals push to their extremes of use. But the very same individual pushing his energies to their extreme, may in a vast number of cases keep up the pace day after day and find no reaction of a bad sort, so long as *decent hygienic conditions* are preserved. His more active rate of energizing does not wreck him; for the organism adapts itself, and as the rate of waste augments, augments accordingly the rate of repair. Generally speaking there is little difference in general health between the individual who consistently works *up to the point of overfatigue* and the one who leaves a large margin."

It should be noted that James refers to "*decent hygienic conditions*." He no more than any other physician or psychologist would advocate the feverish activity that crowds the day and even turns night into day. A balanced, hard day's work, performed by a well person under the proper conditions, and with a healthy state of mind and emotions, leads to no impairment of health; in fact it is an important factor in maintaining both physical and mental health.

Interpretation of Fatigue.

To use one's energies up to the point of overfatigue but not beyond that point requires careful interpretation of the feeling of fatigue. First, the question must be asked, Is it genuine fatigue due to work? In general, when it is out of proportion to the amount of work done, it may be assumed that it is not simple fatigue, and should be medically investigated. Second, when the feeling of fatigue corresponds rather closely to the work done, and thus may be logically attributed to it, the question arises, Is it within safe limits, or beyond? Does it indicate just enough activity, or too much?

The answer to the foregoing questions may be sought by means of two tests; (*a*) the test of productivity in work, and (*b*) the test of recuperation after a night's rest. Both tests will be discussed.

The Test of Productivity.

In general, working power begins to decrease at the point where fatigue begins to be overfatigue. In industrial work, experiments show that production is slower and that more work is spoiled by the same individual when fatigued than when rested. This is largely due to disturbance in the *motor field*—incoordination of muscles and

nerves, and weakness or twitching of muscles, giving awkwardness; and in the *mental field*—faulty attention, distractibility, etc. The aim in industry is to keep workers free from the end-of-the-day and end-of-the-week fatigue which shows as a gradual falling off in productivity.

In the varied activities of a student's life, many of which are not subject to measure and comparison, the test of productivity has limited application. However, it is often possible to gauge the quantity and quality of mental work, and any impairment in these respects should suggest overfatigue as a possible cause.

The "Night's Rest" Test.

Usually there is no reason why a well person should not experiment with the amount of daily exertion. One is usually safe in working as hard as one likes and gauging the results by the way one feels the next morning.

If, after a night's rest, one feels refreshed and ready for another day of equal activity, it may usually be concluded that the work of the day before was not excessive and may be repeated. But if sleep does not "knit the ravelled sleeve" it may be suspected that activity has been out of proportion to one's endurance.

An important consideration in reaching a decision is that the night be *long enough.* Few people can expect to recover from the activities of a busy day in five or six hours, and, if they used that amount of sleep to gauge the amount of exertion they could recover from in a night, they would underestimate their powers. The use of an eight hour sleep period as the standard will give a more correct estimate of the amount of activity that may be undertaken daily with full nightly recuperation. A person who takes less sleep and does not awake refreshed should not feel that his activity was necessarily too much, but that his sleep was too little.

Since slight changes in one's feelings may not be revealed in day-to-day observations, it is desirable to make observations over a longer period. Taking eight hours of sleep a night, and using one's energies to the full during the day, if one feels the same from month to month and year to year, waking each morning as full of vigor as in the past, the habits of using energy may usually be assumed to be satisfactory.

A complicating factor may be present in the case of those who never awake refreshed, who feel sluggish for a time every day, but later "feel like themselves." This may be a lifelong habit in those who show no signs of overfatigue after years of waking up tired. In

general, however, it should be assumed that morning fatigue means overfatigue the day before, and if chronic it should be considered as a state of chronic overfatigue, for the recuperation during the day may be a false recuperation due to nervous stimulation. Such fatigue may, however, be a circulatory matter.

Avoiding Overfatigue.

Two factors are important in making sure that a busy life is a healthful one: (*a*) distribution of time and energy, and (*b*) rest and sleep.

Regarding the former, it may be noted that very active persons who keep well are usually good planners. They arrange the daily program so as to have plenty of time and energy for the things they intend to do. Then, when fatigue overtakes them, they feel at liberty to stop and rest.

Rest and Sleep.

The president of a large insurance company, in an address on the characteristics of people who live longest, mentioned first that these people usually had the habit of resting periodically. Especially for those who wish to use all their available energy, whether the supply is much or little, rest periods during the day may be as important as sleep at night.

The most satisfactory rest is a complete one. A continuous semi-siesta that goes on through lectures and recitations is not ideal as rest, to say the least. On all grounds, it appears most desirable to work while one works and rest while one rests.

Preferably, rest should be taken lying down. This is for the sake of the muscles and joints, and for the circulation. Soldiers on the march stop every few miles to lie flat for a few minutes. Often, they place something, if only the arm, under the lower chest, to stretch the muscles of the chest, including the diaphragm, and so to promote deep breathing and better circulation. This habit is a good one.

To be really restful, a rest need not be long. In fact it appears that occasional short interruptions of work are better than a long one. In many industries it has been shown that a five minute rest period in each hour is enough to keep the workers fresh and to improve the quality of their work. Longer rests may disturb "mental set" and waste too much time in the "warming up" process.

Just as short rests are valuable daily, so are longer ones weekly. The custom of observing a weekly day of rest arose among the an-

cient Hebrews, and has been rather strictly observed throughout subsequent history until this century. Even now, none but essential work is carried on on Sundays except in private life.

For those who work hard six days of the week, a day of rest ideally should be just that—a day with little or no activity except for religious observances. Practically, such individuals often need recreation as much as rest. In such a case, a satisfactory compromise may often be made by choosing recreation that is restful in effect, or at least does not add to the already accumulated fatigue.

The same is true regarding annual rests. In most cases, vacations may be made both pleasurable and also restful, if the physiological need for rest is given due heed.

As a matter of fact, few complete rests—daily, weekly, or annually—would be physiologically necessary if a daily balance were consistently maintained between expenditure of energy and amount of sleep by night.

Sleep is so vital a matter that a separate chapter (Chapter 31) is given to it.

Chapter 31

SLEEP

Why Do We Sleep?

The reason why men and animals have so irresistible a tendency to fall asleep every so often has long been a matter of interest—to laymen and to science. It begs the question to say that sleep is a manifestation of the self-preservative impulse. There must be a mechanism of some sort which serves the interests of this impulse, and the question is, what is it?

One may start with the hypothesis that sleep is the basic state, and try to account for waking; or that waking is the basic state, and try to account for sleeping. Neither effort has been brilliantly successful.

According to the first theory, sleep would be continuous if there were no stimuli to cause the waking state. At first it was suggested that the cortex of the brain is the part that receives these peripheral stimuli that keep one from sleeping. Then it was shown that animals deprived of the cortex still have periods of waking and sleeping. This necessitated another theory, that somewhere else in the brain there is a center—a wakefulness center—that must be stimulated in order to keep one awake. No such center has been conclusively demonstrated, however.

To most people being awake seems like the basic state, the very epitome of living, with sleep as an interruption. According to this theory, we should remain awake continuously if there were no factors that specifically induced sleep. There has been much speculation regarding the nature of such factors.

Because of the resemblance of sleep to narcosis produced by drugs, the chemical theories of the causation of sleep are very attractive. Chief among these is the theory that the products of fatigue, chiefly lactic acid, have a sleep producing effect. It is known that when these products are present in the body in amounts too great to be overcome by their oxidation, they do have a depressing effect upon the activity of the brain—but not in all cases. To be sure, the person who is physically fatigued is likely to feel sleepy, but if thoroughly exhausted may be wakeful. Also, one who exercises after sitting still may be waked up rather than made sleepy. It

seems that fatigue products cannot be considered the only or the invariable stimuli to sleep.

One research worker thought that he had discovered a specific chemical, which he called a hypnotoxin, in the cerebrospinal fluid of dogs killed during sleep, and which, when injected into other dogs, made them fall asleep. Others have failed to substantiate his finding. Another believed he had found that bromine was liberated from the pituitary gland at times, and that this had the usual sleep-producing effect of bromides. This, too, has not been confirmed.

Because of the resemblance of sleep to the unconsciousness during fainting, attempts have been made to attribute sleep to the same cause as fainting—that is, to anemia of the brain. But it has been discovered that in normal sleep, the brain does not lack its usual blood supply. In fact, at the beginning of sleep the brain contains even more blood than usual.

Attempts to locate a special sleep center in the brain, which when properly stimulated causes people to fall asleep, have been unsuccessful. In certain abnormal states somnolence does appear to be due to disturbance in a particular area in the brain (the hypothalmus), but there is little evidence that normal sleep is governed from any single center.

From the evidence available at the present time, it appears that both sleeping and waking are basic states, and that both are to be accounted for not on any simple grounds, but as the interaction of many factors. There appears to be an internal rhythm, which involves the nervous system, the glandular secretions and the general metabolism of the whole body. When a given phase in this rhythm occurs, the need for sleep arises, sleepiness is felt, and one falls asleep. According to this theory, the accumulation of lactic acid would be a part of the story, but not the whole. The whole story is a general condition of the body that requires a change from one state of activity to another—that is, from the active state of waking to the quiescent state of sleep and recuperation.

Support of this theory has been obtained through studying the sleep of animals, most of whom have, like man, a twenty-four hour cycle of sleeping and waking. That the swing from sleeping to waking is not a matter of daylight and darkness nor of variation in temperature or noise, is indicated by experiments with animals kept in the dark, in soundproof rooms at a constant temperature, all of the twenty-four hours. Rats and crayfish in such conditions show complete rhythmicity in sleeping and waking. Rats run eight hours and rest sixteen hours.

In humans, the conditions demanding sleep arise soon after birth. The infant sleeps the first day of his life, wakes of its own accord, and then sleeps again. The rhythm characteristic of adults (one period of waking and one period of sleeping in each twenty-four hour cycle) appears spontaneously in early childhood. Older children and adults normally do not take more than one sleep period in 24 hours unless that period is not long enough.

What Happens during Sleep.

It has always been apparent that sleep brings renewal, and various theories have been advanced in the past to account for it. The physicians of the Middle Ages, for example, believed that during sleep "vapours" were given off, and they especially advocated sleeping with the mouth open, arguing that otherwise "the unnecessary brain vapours have no outlet."

We now know a great deal about what happens during sleep, and what is accomplished thereby. It is known, for example, that during sleep a number of bodily functions are somewhat diminished. There is a reduction in the rate of metabolism; the pulse is slower; the temperature is lower, and the activity of the heat-regulating mechanism is reduced; the blood pressure is reduced; the rate of breathing is slower (although its depth is increased); certain secretions are produced in smaller amount (saliva, urine, tears); and the tone of the voluntary muscles is reduced almost to nil. Other functions go on as usual, including that of digestion. One of the few functions that is more active during sleep is that of sweat secretion, which may be as great as during exercise.

It will be seen that sleep provides rest for a number of functions. That in itself would make sleep an advantage to the body, but it is not the whole story. What enables one to count upon waking refreshed every morning is the fact that during the night the body is the scene of active renovating processes. While the body's energy is not being used in outward activities, it is used for the repair of any tissues that have suffered from the previous day's wear and tear. That such repair processes actually do take place faster during sleep than during waking can be scientifically demonstrated. For example, the skin cells, which must constantly be produced, divide about twice as often by night as by day.

However inert the body appears while asleep, it is actually the site of the most constructive and life-preserving activity. All tissues and organs of the body profit by their nightly seasons of up-building. It is to aid in this unperceived cell activity that all animals sleep.

The situation is somewhat similar to that of an electric battery to run a machine. If connected with a generator it is being constantly charged while the machine is in action, but charged at a higher rate when the machine is at rest.

Biologically sleep is not a negative thing, but a positive vital function, as important as the taking of food, water, and oxygen. Life cannot go on unless all of these four essentials are supplied in due amounts.

Effect of Lack of Sleep.

Experiments have been conducted with animals and with humans to determine how they were affected by lack of sleep. In one of the colleges, four students volunteered to remain awake as long as possible for scientific observation of the result. One of them became sleepy so soon that data are available for only three. They stayed awake about 54 hours.

The most conspicuous effect of their long wakefulness was in their dispositions. They became so extremely irritable that they had to be watched "to keep them from flying at each other." This effect has also been noted in animals. In one investigation, the chromatin in the nuclei of the nerve cells in the brain cortex had undergone degeneration.

These students also showed changes in vision. They were unable to see clearly, could not distinguish colors as usual, and had a poor sense of perspective.

Muscular coordination was also impaired; the students were unable to hit a nail on the head with a hammer, or to write as well as usual, or aim correctly at a target.

All the foregoing symptoms are manifestations of effects on the nervous system. Still others have frequently been noted—for example, increased sensitiveness of the skin to pain. Numerous tests have shown that the ability to remember and to concentrate attention, and to solve problems is definitely impaired in those who have been awake for long periods.

The effects of less extreme loss of sleep have often been studied, and it has been found that in many people similar symptoms, although less in degree, will appear after they have missed only one hour of the accustomed sleep.

On the basis of much evidence, it appears that after the loss of a moderate amount of sleep, working capacity may remain the same, but that the same amount of work requires more energy, and that the quality of the work is not so good as the individual's

usual standard. In manual work, as in industry, the percentage of spoiled work may increase 100%, owing to the effect on eyes, muscle coordination, and mind. In mental work, there is apparently a marked difference in individuals—the effects ranging from almost complete incapacity after loss of a little sleep to very nearly normal capacity after loss of much.

Whatever the differences in the response of individuals to lack of sleep, there appears to be a point for each one, below which sleep cannot be curtailed without producing some or all of the symptoms mentioned, and perhaps still others.

In all persons, the effects of lack of sleep are cumulative, with eventually a measurable impairment in working capacity.

Amount of Sleep.

James Thompson, the Scottish poet, in "The Castle of Indolence" voiced the question of many people both before and since his time when he wrote "Is there aught in sleep can charm the wise to lie in dead oblivion losing half the fleeting moments of too short a life?" Whether charmed or not, that is what mankind actually does (if we interpret the poetical "half" as a literal one-fourth to one-third) and has been doing in all races and in all times, according to all available records.

When one stops to consider that the average person who lives to be 70 years old has had his 20 years of sleep—just as Rip van Winkle did—and that he has been awake only 50 years, the question naturally arises, do we need so much sleep? Granting that sleep is a time of rebuilding, we ask whether the restorative processes would not take place in a shorter time than we usually allow them.

In a busy and happy life there appear to be many more profitable ways to spend one's time than in sleep; yet it appears to be scientifically unquestioned that it takes nearly a third of the twenty-four hours in sleep for the average adult to be in condition to live to the full the other two-thirds of the time. The amount that will keep most adults from showing evidence of lack of sleep is, on the average, from six to eight hours, and instead of complaining, we should be glad that humans, unlike most animals, can successfully and harmlessly keep awake so many hours of the twenty-four. It adds to man's adaptive power.

Individuals are, of course, not precisely alike in the amount of sleep that puts them into the best condition. The amount varies according to the constitution of the individual and a variation in the rate of recuperation, and also upon the activities of the indi-

vidual and the tension under which he works. Rumors circulate about great men who take little sleep, but upon investigation some of these seem to be unfounded and the others are explained on the grounds of unusually deep sleep, as in the case of the deaf, or of daily naps, or of both (e.g. Thomas Edison).

Therefore, the soundest statement about the required amount of sleep would seem to be not in figures but in the word *enough*—enough to restore the individual and keep his vigor at a high level from one day to the next.

Among college students, the one really serious bad habit that most often prevails is that of ignoring the need for sleep. Unfortunately, the harmful results do not always become evident at once, and are not always measurable. One cannot easily estimate how much of one's vitality and working power, keen wits, good looks or disposition one has lost by losing sleep. But there is a way of determining whether one's present sleep schedule is satisfactory: in case of doubt, one may add a half hour to one's usual hours of sleep for two weeks, and notice whether one is improved in these various respects. If a half hour helps, one might then add another half hour for another two weeks and see if that helps still more. By such experimentation in increasing the hours of sleep, one may arrive at a standard for one's self.

Sleep before midnight is often spoken of as especially valuable. It is, of course, the same as all sleep. But the person who sleeps before midnight is more likely to get enough sleep and to show it—hence the term "beauty sleep."

Making Up Lost Sleep.

With the best of principles and the most regular habits of sleep, one cannot always follow the schedule. The question arises, can lost sleep be made up? Shakespeare suggests, in "Othello," that it cannot. He says,

> "Not poppy, nor mandragora,
> Nor all the drowsy syrups of the world,
> Shall ever medicine thee to that sweet sleep,
> Which thou ow'dst yesterday."

It is probably true that the strain of long hours without sleep is not entirely overcome for some time. Nevertheless, to attempt to make up for the loss at the earliest opportunity is the best that one can do, and it is often entirely satisfactory.

Napoleon, a man of extraordinary energy, who said, "I am conscious of no limit to the work I can get through," slept from

six to eight hours a night, and in times of greatest stress would often sleep the clock around. It is reported that he even slept 36 hours "at a stretch" on one occasion during the Russian campaign. It was his principle always to sleep an extra number of hours as soon as possible to balance exactly the number lost. Many other vigorous and successful people have that habit.

Undue Need for Sleep.

When a person "never can get enough sleep" even though he sleeps eight or even more hours, the question is whether he really needs still more, or whether there is something in his hygiene, his health or his conditions of sleep that needs change.

Sleepiness in the morning often occurs in those who are high strung and intense, and who virtually exhaust themselves in the day's activities; and in those of the opposite type, sluggish in their bodily processes, and inactive in their habits. Similarly, sleepiness before bed time may also occur in the same two types of people.

In many cases, in any type of person, an undue need for sleep is entirely an environmental matter—night time conditions not being favorable for sleep, and daytime or evening conditions not being favorable for staying awake.

In some cases, undue need of sleep is a manifestation of some bodily disorder. For that reason, if it persists, it should be investigated.

Night Study.

Modern science does not quite agree with Erasmus who said "Never work at night; it dulls the brain and hurts the health." Possibly the advice would not have been given if artificial lighting had been as good in the 15th century as it is today. But perhaps Erasmus meant to imply that the hours for sleeping should not be used for work, and everyone who has ever found his wits wandering during an examination after a night of cramming will agree with him.

Quite certainly Erasmus knew nothing about the "night owl" type of person, who cannot work by day and must work, if at all, by night. In those days, with houses heated only by hearth fires, often without chimneys, and lighted only by candles or open oil lamps, the natural tendency would be to go to bed shortly after dark. Today, with conditions as favorable by night as by day, not a few people have developed a reversal of normal habits. Instead of feeling wide awake in the morning and sleepy at bedtime, they are sluggish during the day and gradually wake up as night draws on, until they reach a peak at midnight or perhaps later. This

habit appears to be more common in those particularly interested in things of the mind and not having a normal amount of physical activity during the day.

Such individuals naturally hate to sacrifice their best working time to sleep. The question is whether they should try to turn their sleeping and waking cycle to make it conform to that of the majority. From the health point of view, the major consideration is that of getting enough sleep during the twenty-four hours. If it is possible for such individuals to sleep late in the morning, their habits probably do them no great amount of harm.

The tendency to be a "night owl" is hard to overcome, undeniably. Yet it is not impossible, for such individuals are not intrinsically different from others, but merely of different habit. The method of correcting the habit is, of course, forcing one's self to go to bed at a given hour, and then forcing one's self to get up again at a given hour. Usually, after earlier hours are established, the fund of energy also becomes available earlier.

Falling Asleep.

The most important predisposing factor for sleep seems to be that of being in bed. Pavlov, whose theory was that sleep is an inhibition of positive conditioned reflexes, found that in animals he could condition the inhibition, so that they would tend to fall asleep in the same spot where they previously had slept. Others have noted the same tendency. Some attribute it to suggestion. Certainly it is true that individuals usually do go to sleep more readily in a bed than anywhere else, and in their own accustomed bed more readily than in any other.

In connection with the rhythmicity of sleep, it has been noticed that the arrival of a given time is also a strong predisposing factor for sleep. Those who have a regular bedtime seem more likely to fall asleep promptly after going to bed. This appears to be the case in children, and in many adults.

Although the habit of falling asleep tends to assert itself according to location and time, other conditions favor its operation. It is particularly likely to operate promptly if the following conditions prevail: first, the general condition of the body is physiologically favorable for sleep; second, the body is comfortable; third, the muscles are relaxed; fourth, the eyes and the ears are receiving no strong sensory impressions; fifth, the temperature sense is not being stimulated by too much heat or cold; sixth, the mind is at rest.

Physiological Conditions.

It appears clinically true that sleep is favored by the presence of just the right amount of *bodily fatigue*, neither too much nor too little. In the case of too much fatigue, the difficulty may be attributed, at least partly, to excess of fatigue products, causing irritation of the cerebral cortex. It may also, especially in the case of "nervous fatigue," be due to an undue amount of muscular tension, and difficulty in relaxation. In either case, a warm bath is likely to be of assistance. In the case of too little fatigue, the remedy is often a small amount of exercise before bedtime.

Second, various matters involving the *distribution of the blood*, as between the brain and other parts of the body, have an important effect on sleep. Among them may be mentioned the state of the digestive tract. If it is too actively engaged in digestion, it appears that in some people it delays sleep, or makes sleep less sound. On the other hand, many people find that eating something light (e.g. a glass of milk or a few crackers) at bedtime makes them sleepy. The temperature of the bedtime bath also influences sleep. Few people can fall asleep immediately after a very hot bath or a cold one, but most people are soothed by a warm one, at not much more than body temperature.

Environmental Conditions.

To favor sleep, the environment should be dark, quiet, and cool. Of these, perhaps darkness is the most important. In those who need sleep, darkness by itself (as in a steropticon lecture) may prove an adequate stimulus to sleep.

In respect to both *darkness* and *quiet*, individuals vary in the degree of each they need for falling asleep and sleeping soundly. Some cannot sleep with a radium-faced clock ticking in the room. Others sleep well even in a college dormitory without "quiet hours"—or even in a classroom.

Most people find that they can easily become accustomed to any habitual conditions in the outdoor environment, such as sounds and noises from city streets, but that indoor conditions are more disturbing, partly because they are nearer and partly because they have more personal significance. It is usually possible, however, to train one's self to ignore all but the most personal of stimuli, such as the sound of one's own name.

For ethical reasons, it behooves roommates and housemates to agree upon an hour after which there shall be no unnecessary noise or light. That hour should be at least eight hours before the rising

time, so as to allow every member of the group an opportunity to obtain the necessary sleep. To create conditions that keep another person from sleep would appear to be quite on a par with stealing his food.

As for *temperature*, the most comfortable temperature is the best one in which to sleep. Here again, people differ. Most people will be comfortable with the temperature of the bedroom from 60–65° F. This means that in winter the heat must usually be turned off and a window opened according to the weather, perhaps only an inch, or a few inches, on the coldest nights. If correct temperature could be secured, without opening a window, it would usually not be wise to leave the windows closed, for a gentle current of air appears to be conducive to sound sleep.

Throughout history, doctors have always advocated that the individual should be comfortable while sleeping, neither too hot nor too cool. But custom has varied between two extremes regarding the method of obtaining that comfort.

In the remote past, the custom was to wrap one's self in skins and huddle around the hearth fire. Even up to the Renaissance there were no separate sleeping rooms. Beds were in the living quarters where the fire was, and were shrouded in heavy draperies, which were kept drawn all night. To add to the "comfort," the unglazed windows were covered with boards.

There was little change in sleeping conditions, even after the introduction of the bedroom, until the 19th century, when the heating of houses by furnaces became general. Furnaces created problems in ventilation, and ventilating engineering developed as a science. Much stress was placed on the need for fresh air, which many people interpreted to mean that in bedrooms all the windows should be wide open all night, whatever the temperature. To counteract the cold, the "fresh air fiends" slept under mounds of covers. The absurdity of admitting so much cold air into their rooms and then doing everything possible to overcome its cooling effect upon them did not become apparent for several decades. Some people still prefer to secure comfort by means of many coverings in a cold room. It probably does them no harm, but they would certainly be just as well off with fewer coverings in a warmer room.

In any case, the sleeping person should be protected from draughts, owing to the fact that the heat-regulating mechanism is less active during sleep. Architects are now planning houses so that each bedroom has a suitable location for the bed, where it will be out of draughts. Charles Dickens had another idea about the loca-

tion of beds. Wherever he went while travelling in this country, he carried a pocket compass and insisted that the bed on which he was to sleep be placed with its head to the north.

The *bed* itself is important in its effect upon soundness of sleep. It should have a firm spring and mattress that will not sag under the weight of the body, 50% of which is distributed at the hips when lying down. It is necessary for the sake of the circulation, and also for the sake of the joints of the hips and lower spine, that the hips should not be lower than the chest or the heels.

The beds of ancient Egypt met this requirement admirably, for they were carved out of stone. So also did the beds first used in Greece, with "springs" made of leather thongs or strips, supporting mattresses stuffed with straw or with feathers. Beds such as these continued to be used without any improvements until the 19th century, when wire springs were invented (by James Liddy, of Watertown, New York).

It was many years, however, before spring manufacturers learned how to make springs that were yielding and yet would not sag. Such springs are available now at any price; yet manufacturers say that comparatively few people demand anything but softness in a spring or mattress, and that they themselves have had to "talk up" the sagless bed.

Beds should also be well made up. The lower sheet should be large enough to tuck in all around. All covers should be long enough to tuck in at the foot and cover the neck and shoulders, and should be left loose at the sides. Blankets and puffs should be light in weight (i.e. all wool blankets, and down or wool puffs).

The State of Mind.

After one has gone to bed, provided physical and environmental conditions are correct, mental relaxation tends to accompany muscular relaxation. However absorbing and interesting one's ideas, or even however unpleasant and disturbing, they tend to dim as one composes one's self in bed, in quiet and darkness, with the muscles relaxed. When they persist, and keep one awake, it is usually because one insists upon it. If one stops voluntary thinking and allows the mind to wander at will, it usually wanders toward sleep at bedtime. This is all that most people need do to prepare their minds for sleep—simply to let go the reins that keep the mind travelling along any planned route.

Some, however, need to banish the fear of not sleeping. Knowing how important sleep is, many people become much concerned

if they lie awake even a few minutes after they go to bed. This concern keeps them awake still longer, and they become more disturbed, and so on, in a vicious circle of sleeplessness and fear of sleeplessness. It is such people who have made "sleep shops" profitable by the sale of all sorts of gadgets supposed to induce sleep.

The fear of not sleeping is entirely unwarranted. In the first place, rest in bed is a very good substitute for sleep, at least for part of the night, provided one accepts the situation and does not become tense in rebellion against it. Moreover, sleep actually does come sooner or later, and it may be sound enough to make up for its shorter duration.

It is doubtful whether any well person ever stayed awake in bed all night, or that any well person was ever very greatly harmed by resting quietly in bed instead of sleeping for a part of the night. It is the fretting that accompanies wakefulness that causes recuperation to be less complete. In any case, fretting is precisely the attitude that prevents sleep, and nonchalance the attitude that invites it.

Not only is a period of wakefulness harmless, but it may even be worth while. An idly wandering mind may produce an idea of great value. Frederick Banting is said to have conceived the idea of how to extract insulin from the pancreas in the small hours of the morning, after he had been lying awake some hours.

The biographer of William Harvey, the discoverer of the circulation of the blood tells of no nocturnal inspirations that came to Harvey, but does tell of his method of setting the conditions for falling asleep. "His thoughts working would many times keep him from sleeping, in which case his way was to rise from his bed and walk about his chamber in his shirt till he was pretty cool and then return to his bed and sleep very comfortably."

As in the case of Harvey, often some minor adjustment in the physical condition or the environment is an aid in slowing down the train of thought. Also, there are a few adjustments in the state of mind that are helpful.

Among them, the foremost is that of reading. It serves not so much to slow the train of thought as to divert it entirely from its previous channel. According to the individual, different sorts of literature may serve—light and trivial in vein, or lofty and uplifting; interesting, or uninteresting. Of course, due precautions must be taken while reading in bed, not to strain the eyes.

It is recorded that in Arabia, reading was considered so important an aid to sleep that professional readers were supplied by the pharmacists, upon doctors' prescriptions. According to Pavlov's

theory of sleep, the soporific effect of listening to reading in a monotonous tone would be attributable to inhibition of positive conditioned reflexes rather than to the content of the material.

Drugs.

Medicine to produce unconsciousness may be a boon to the sick, but a boomerang to the well. Most of the commonly used "sleep pills" are powerful drugs, to which their users tend to become addicted and from which they may suffer chronic poisoning.

One such drug in a recent year was sold to the extent of 130,000,000 doses, of which it was estimated that three-fourths were "over the counter" sales, without prescription, to addicts. Among the symptoms produced in addicts to this particular drug are anemia and mental depression up to the point of dementia. Obviously, such a drug is entirely unsuitable for self-treatment. The same applies to drugs having the opposite effect, that of preventing sleep. At least one tragic case is on record of a student who died during an examination after having taken a medicine—so-called "pep pills"—to keep him awake for cramming the night before.

Dreams.

We are justified in disowning our dreams. To be sure they represent activity of our brains, but not of the higher areas we recognize as our "real selves."

Physiologically dreams appear to be mental activity that occurs when the higher cortical areas of the brain have gone to sleep, and the lower areas are still awake. Restraint from the higher areas being absent, the less critical areas carry on unrestrained and often somewhat riotous "thinking," until they too are inhibited by sleep.

Studies of the electric potential of the brain cortex, as charted in the form of a hypnogram (*hypno*, sleep) shows that sleep does not come all at once. During the early stage of sleep, when the higher areas only are inhibited, the brain wave pattern of a normal person is much like that found in abnormal mental states. But in deeper sleep, the brain wave characteristics of different people become very much alike. However, even during deep sleep there are frequent changes in the hypnogram. These come either with or without external stimuli. Presumably they represent changes in the level of consciousness, and when they come without external stimuli they may indicate that dreaming is going on. With such changes in the hypnogram, increase of blood pressure may accompany a rise to a higher level of consciousness, such as might occur during a dream involving action.

The material of a dream is pieced together from every day experience. Its individual items may often be traced to their source in recent happenings, things seen and heard, often scarcely noticed at the time, and in sense impressions from the body. Almost anything seems to serve as material for constructing new scenes and incidents, often extremely vivid, and perhaps so odd and so unlike the waking thoughts as to seem entirely foreign to the waking self. There is much in common between dreams and the often fantastic products of the unrestrained and uncritical imagination of childhood. An eminent physiologist, who is also an experienced dreamer, calls attention to the fact that at least in dreams, no person ever seems to grow old and sedate.

As for the meaning of dreams, most scientific people believe that they have none. However, there is one school of psychology (psychoanalysis) that believes dreams are symbolic expressions of the unconscious self, and that their significance in the individual who dreams them can be discovered by a deep analysis of that person's mind. Psychoanalysts state most definitely, however, that dreams do not mean what they seem to mean, nor do they mean just the opposite, nor indeed anything that could possibly be discovered by anyone who had not had the years of training necessary to master the highly specialized technique of psychoanalysis.

From time immemorial man has been fascinated by dreams. Every primitive race had great respect for them, believing that they had meaning, and developed systems for interpreting them. It has been estimated that more books on dreams have been printed and sold than on any other subject. And the end is not yet; vast numbers of people take more stock in what a dream book says than in any book of science.

Whether dreams make sleep less refreshing is difficult to determine. However, it is known that many of the most prolific dreamers apparently suffer no ill effects from it. It may be that the lower cortical centers need not be entirely inhibited for sleep to be sound. However, if a person dreams a great deal and is in any way annoyed by it, he might consult a physician. Possibly some factor in the way of living or in the bodily condition might be modified so as to inhibit cortical activity more completely.

Walking and talking during sleep are on a par with dreams, the only difference apparently being that they include motor as well as mental activity. The assistance of a physician, possibly a psychoanalyst, may be needed to correct the habit, although it commonly does not persist long after childhood.

Chapter 32

BODY TEMPERATURE

"Warm-blooded Animals."

In respect to their body temperature, animals are of two sorts, homothermic and poikilothermic. The former (birds and most mammals) are known as warm-blooded, because their temperature remains fairly constant regardless of the temperature around them. The latter (e.g., fish, reptiles) are known as cold-blooded because their temperature is not constant but varies according to the temperature of the medium (air or water) in which they live, and is cold if they are in a cold medium. If the poikilothermic creature finds itself in an unfavorable temperature it quickly dies. Mountain trout, for example, die if the temperature of the water reaches 75–80° F. Numerous lower forms of life are as dependent upon suitable external temperature as upon nutriment. The ability of certain bacteria to survive in unfavorable temperature is because of their ability to go into a state of suspended animation in the spore form.

The warm-blooded animals, on the contrary, adjust more or less completely to outside temperatures, and can live and be active in a wide variety of climates. Man can survive brief exposure to a range of nearly 300° F., and can make his abode in climates ranging from well below zero to somewhat above 100° F. Part of man's adaptability is, of course, due to his ability to make intelligent use of numerous aids to temperature regulation.

Normal Temperature.

Man's normal temperature is 98.6° F. when measured by the clinical thermometer in the mouth. Although there is some variation in the temperature of different parts of the body, it tends to be nearly equalized throughout by the constant flow of blood from warm parts to cool ones, and vice versa.

It should be understood that the term body temperature refers to the interior of the body. At most external temperatures, the skin is much cooler than the interior. Body temperature cannot be estimated by the feelings, for the perceptions of heat and cold arise

only from the skin and the mucous membranes near the body apertures. One is not aware of variations in internal (body) temperature except as a result of experience in interpreting some of the associated symptoms.

Body temperature varies only slightly in health, except among the very young and the very old. Infants and the aged are somewhat like poikilothermic animals, in that the former have not yet acquired, and the latter have lost, the ability to maintain stable temperature. In all persons, there is some diurnal fluctuation, the highest point being at about 4 P.M. and the lowest at about 4 A.M., at which time the temperature may be only 97° F.

Conditions in and around the body may cause its temperature to rise above or fall below normal, but man cannot survive any prolonged variation of more than a few degrees either way. The normal temperature is the one at which the body cells function best.

Causes of Variation in Temperature.

The factors that cause the body temperature to vary are: (*a*) the amount of heat produced in the body; (*b*) the amount of heat applied to the body from the outside; and (*c*) the amount of heat lost from the body.

Heat production and heat loss are always going on. If either stopped, life itself would stop. The problem in favoring correct body temperature is that of balancing these two factors in respect to each other, and of balancing both against external factors. Variation in body temperature occurs when these factors are not accurately balanced.

Heat Production.

Heat is produced in the body by every active cell, as an accompaniment of activity. Naturally, the most active cells—those that carry on the greatest amount of oxidation—produce the most heat. Since the muscle cells are the most numerous of the active cells, they may therefore be looked upon as the "fireplaces" of the body. They are constantly in action to some extent, whether the body is moving or not. This characteristic of muscle cells is known as tonicity, which implies constant slight contraction. Even at rest, the body produces more heat than it needs to keep its temperature 98.6° F.; and when active, it produces a still greater excess of heat. One hour's heat production would raise two quarts of water to the boiling point. During such activity as playing 18 holes of golf, enough heat may be produced to raise a ton of water one degree Centigrade.

In severe exercise the body temperature may run up to 104° F. Most young children after even moderate exercise show a rise of a degree or two of temperature which may persist from afternoon play until bed time.

The taking of food also has a heating effect upon the body. It should be understood that making more fuel available for combustion does not necessarily mean increasing the amount of combustion, since combustion occurs according to the degree of cellular activity. The heating effect of taking food is due to two factors.

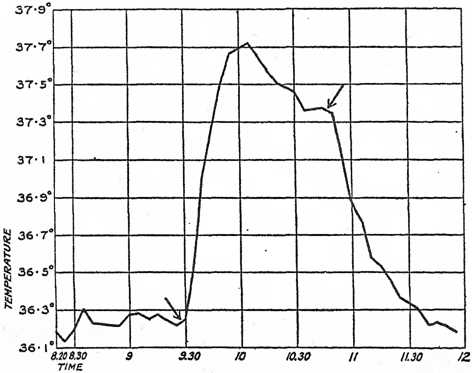


FIG. 131.—Rise of body temperature after exercise which began and ended at the points indicated by arrows. (The increase of 1.5° C. is equal to 2.7° F.) (Winton and Bayliss.)

First, the digestive organs become more active while digesting it, and this adds a little to the combustion going on in the body. Second, certain chemical products of food, especially of protein foods, have a specific effect on the heat-producing process in cells, to a comparatively small extent.

If the food taken is hot, the body acquires a small amount of heat in that way.

Heat Loss.

The body obviously is equipped to overheat itself grievously, and would do so if it were not also equipped to cool itself adequately. The situation is much the same as with a gasoline engine,

that consumes fuel, generates energy, becomes heated, and requires a mechanism for cooling.

Excess bodily heat is given off largely through the skin, and to lesser extent through the lungs.

Cooling at the surface of the body takes place in four ways. First, heat is given off by *radiation*, as from all heated objects, such as the sun or a hot stove. That loss of heat takes place in this way from the body is shown by the increase in temperature in a room in which a person is enclosed. Second, heat is given off by *conduction*, as from any heated object to a cooler object or substance with which it is in contact. The body when in contact with ice is cooled to the same degree that the ice is warmed and melted. Third, heat is removed from the body by *convection*—that is, it is blown away on currents of air. Fourth, body temperature is lowered by *evaporation of moisture* from the skin. This process takes place in a quiet atmosphere but is more rapid when aided by convection.

The lungs also take part in cooling the body. First, evaporation of moisture occurs from the air passages. That moisture is contained in the expired breath may be shown by breathing upon a cold object upon which moisture will condense. Second, the lungs take in air cooler than the interior of the body, and they lose heat to the same extent that the air is warmed.

A small loss of heat also occurs when the digestive tract gives up heat in warming cool food and drink.

The total loss of heat from the body by these various routes, in the case of an adult sitting in average clothing in a room at 70° F. will be approximately as follows:

By transfer and evaporation from the skin	85%
By evaporation from lungs	10%
By transfer to air, food and drink	5%

Obviously, the amount of cooling that takes place at the surface will depend upon external conditions to some extent. As will be shown, it also depends upon various factors in the body itself; in some bodily conditions, cooling takes place more rapidly than in others.

Thermostatic Control.

The tendency of body temperature to remain at about 98.6° F. is due to a balance between heat produced and heat lost. To maintain this balance, there exists in the body an automatic mechanism which may be likened to the thermostat which governs temperature in a house.

The body's thermostat consists of a nerve center in the brain, which is stimulated (*a*) through *sensory nerves* from the skin, conveying messages of heat or cold; and (*b*) through the *temperature of the blood* flowing through it. When the body begins to be overheated, or overcooled, appropriate messages are sent out from the temperature-regulating center to increase or decrease the loss of heat or the production of heat.

Functions Involved in Temperature Regulation.

Five functions are activated from the temperature-regulating center whenever the body temperature threatens to become too

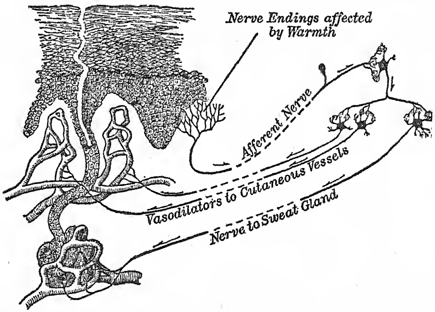


Fig. 132.—Diagram of the cutaneous reflexes for temperature regulation, showing the epidermis, blood vessels of the dermis, a sweat gland, and the nervous mechanism governing blood vessels and sweat glands. Note one afferent and two efferent pathways. (From Hough & Sedgwick, "The Human Mechanism." Courtesy of Ginn & Co., Publishers.)

high or too low; (*a*) vasomotion in the skin, or the control of the caliber of the blood vessels, and consequently of the amount of blood, in the skin; (*b*) secretion of sweat; (*c*) respiration; (*d*) muscle action; and (*e*) endocrine gland action. All five of these functions come into play automatically, and through their coördinated work the temperature tends to be held at the normal level if the odds against it are not too great.

Vasomotion in the Skin.

Since the blood is almost always warmer than the surface of the body, it will be cooled when present in the skin. Obviously, in

given external conditions, cooling takes place in proportion to the amount of blood in the skin.

The blood vessels in the skin are under the control of two sorts of nerves—those that dilate them (vasodilators) enabling them to hold more blood, and those that contract them (vasoconstrictors) reducing the amount of blood they can hold. These nerves are stimulated reflexly by local conditions, and also as a result of distant conditions. They tend to act automatically, in response to the general need of the body for cooling or for conserving of heat.

When the body is to be cooled, impulses travel from the brain centers causing the blood vessels of the skin to dilate, which permits a large amount of blood to flow into them from the heated interior of the body. When the skin is in contact with air or water at a lower temperature than the body, the blood in the skin is cooled, and when it flows back to the interior of the body, the interior will be proportionately cooled.

Conversely, when the body is to be kept from cooling the vasoconstrictor nerves in the skin react, and, as the blood vessels narrow, the blood in them is sent to the interior of the body and escapes being cooled at the surface.

The extremities, especially the lower ones, show the most marked vasomotor changes in response to the need for temperature regulation; the trunk and the forehead, the least.

At temperatures below those that induce visible perspiration, cooling of the body is carried on largely by transfer of heat depending on variations in the distribution of blood to the skin.

Secretion of Sweat.

Cooling of the body by evaporation from the skin is in proportion to the activity of the sweat glands. They constantly produce a small amount of perspiration which is not perceived because it evaporates at once. When external temperature is about 66° F. the amount of perspiration begins to increase and continues to increase as temperature rises. The temperature at which visible perspiration appears varies in different individuals. In general, the threshold in women is several degrees higher than in men. Often they do not perspire visibly until external temperature has reached about 90° F.

Two sorts of nerve impulses affect the sweat glands. First, they are affected by vasomotor nerves, which determine how much blood is present in the skin. Since they are located in the skin, any increase or decrease of blood in the skin determines how much fluid is available to the sweat glands from which they can manu-

facture sweat. Second, they are affected by nerve impulses directly to them, which determine how active they actually become in utilizing their increased blood supply. These secretory impulses may occasionally be stimulated when conditions do not call for increased evaporation, and quite apart from any excess of blood in the skin. For example, such emotions as fear or such physical conditions as shock may give rise to "cold sweat."

In general, the sweat glands tend to be activated whenever the cooling of the body cannot be satisfactorily managed by transfer (radiation, conduction and convection) to the surrounding medium. That means that they are activated when the body becomes very warm as a result of heat production during exercise and as a result of a hot environment. When atmospheric temperature reaches 70–80° F. evaporation becomes an important means of loss of heat; and the only means, when external temperature equals body temperature.

The humidity of the atmosphere determines the amount of additional moisture it can take up, and therefore the possibility of cooling by evaporation.

Respiration.

Breathing becomes automatically faster when the body is warmed, and slower when cooled. This effect is more conspicuous in animals not having sweat glands all over the body. For example, dogs perspire little except on the pads of the feet, but they pant on hot days, evaporating much moisture from the mouth, throat and lungs. Panting is rapid but not deep respiration. The same phenomenon occurs to some extent in man.

Physical and Chemical Methods.

It will be noted that the three functions already mentioned (vasomotion, sweat secretion and respiration) permit the regulation of body temperature by physical means (radiation, conduction, convection and evaporation). These methods are therefore called the physical control of temperature. By variations in these *physical* methods, heat may be conserved or lost in varying degree.

However, the matter of heat production may also be varied to some extent. That is a chemical matter—involving the degree of oxidation that takes place in the body, chiefly in the muscles. Changes in metabolism constitute the *chemical* methods of temperature regulation. They include muscle action and endocrine gland action.

Muscle Action.

Involuntary changes in the amount of heat produced in muscles occur to some extent when conditions require more bodily heat, or less. When the body tends to become over-heated, the muscles reduce their tone so as to produce less heat. This relaxation gives the familiar "limp" feeling experienced in hot weather. This limitation of heat production amounts to nothing however, if the muscles are used in voluntary contraction. It will be evident that checking of heat production by reflex muscle relaxation is ordinarily not an important measure in temperature regulation, since there is a minimum below which heat-production cannot go.

When overcooling impends, the muscles increase their tone so as to produce more heat. This increased contraction of the muscles accounts for the familiar "bracing" effect of cold weather. Additional demands for heat production are met by the act of shivering, which consists of involuntary contractions of separate groups of muscle fibers in a way that does not contract the muscle as a whole. At the same time, the teeth may chatter because of involuntary contraction of the jaw muscles, and "goose flesh" may appear. The latter phenomenon is due to contraction of the small muscles in the skin each of which is connected with the root of a hair. In animals, this results in bristling of the hair, and in birds in fluffing of the feathers. In them it is an important means of conserving body heat, but can scarcely be considered so in man, except as it contributes to awareness of being cold and of a need for voluntary measures to warm up.

Reflex muscle action adds somewhat to body heat, but its most important effect is that of a warning to make larger muscle motions, thereby producing still more heat, or to take steps to conserve heat.

Endocrine Glands.

As has been mentioned, the rate at which metabolism (chemical change, with heat production) occurs in the body is regulated by the endocrine glands, notably the thyroid and the adrenal medulla. In response to cold the adrenal gland stimulates heat production and also takes part in constricting the skin blood vessels so as to restrict heat loss. It is probable that reaction on the part of the adrenal gland is effective in minor needs for conserving heat, and that shivering does not occur until greater needs for heat production arise.

The thyroid gland appears to be of less importance in the quick response to the need for heat than in adaptation to long prevailing

environmental conditions. A constant state of over or under activity of this gland markedly affects the individual's ability to maintain body temperature at the normal 98.6° F. Those who secrete too little thyroxine may regularly have subnormal temperature; and vice versa. In either case, the departure from normal is due to changes in the rate of metabolism.

Constitutional Factors.

Certain constitutional factors influence the success of automatic adjustments to temperature. Among these the most important are the following.

First, *age* is a factor in promoting normal response to variations in temperature. During the first year of life, the ability to produce heat becomes effective before the ability to lose heat. Therefore, although the infant needs to be kept sufficiently warm, great care must be taken not to permit its over-heating. In the aged, instability of temperature is due chiefly to inadequate heat production.

Second, the *amount of fat* on the body affects the degree to which cold penetrates and heat departs. A thick layer of fat acts as insulation. Other things being equal, the fat person tends to feel the cold less than the thin person, and the heat more.

Third, many matters of *health* determine how effective the automatic apparatus will be in governing body temperature. In general, those who are not well suffer more from either extreme of external temperature, and from sudden changes of temperature, than do the vigorous.

OVERHEATING

Sunstroke and Heat Stroke.

The harmful effect of too intense sunlight is partly due to heat rays and partly to other rays of the sun such as the ultraviolet. For practical purposes, sunstroke may be classed with a similar condition, heat stroke, produced by extreme heat of itself. Either may be fatal, or seriously impair health.

Three sets of factors are usually involved when sunstroke or heat stroke occurs: first, the *atmospheric condition* (a combination of high temperature, high humidity and lack of air motion, with or without solar radiation); second, the *individual's state of health;* third, the *individual's behavior*. A person who succumbs to the heat has usually been physiologically unfit to adapt to it, and has exposed himself to it too long under unfavorable conditions.

Those who stand the heat poorly are the very young or the very old, the feeble (those who are ill with any acute or chronic disease, or are convalescent, or are thin and malnourished), the obese, the alcoholic, those who have been perspiring freely and thereby have lost much salt from the body, and those who lack the ability to perspire enough.

Even those who are well would find adaptation to extreme heat difficult if exposed while overclad, or after too hearty a meal, or after missing a meal, or while muscularly too active, or while asleep or unconscious, or while under the influence of alcohol.

In sunstroke or heat stroke, the temperature rises, often to a higher level than any fever. The skin is flushed and hot, the pulse strong, and the victim usually unconscious. The remedy is cooling him as quickly as possible, preferably by pouring cold water over him. The head should not be low. Nothing should be given by mouth.

Heat Exhaustion or Prostration.

The conditions leading to prostration by heat are the same as those leading to heat stroke. The effect is different, however. In this case the temperature does not rise, but falls. The skin is not flushed, but pale, cool and moist. The pulse is weak. Usually the victim is not unconscious, except perhaps for fainting. This condition is due to collapse of the heat-regulating apparatus, and secondarily of the other vital functions. The remedy is warmth, quiet, stimulants and salt.

Heat cramps in the muscles often occur in those exposed in their occupation to excessive heat. They are due to dehydration and loss of sodium chloride by excessive sweating. The drinking of a great deal of water replaces the lost water, but not the salt. Adding salt to the drinking water, in the proportion of one-fourth of a teaspoonful to a quart (or "a pinch" to a glass) prevents or relieves heat cramps.

Moderate Overheating.

The person who is exposed for a long period to less extreme conditions, or who is vigorous enough not to react in so extreme a way to external heat, may still suffer to some extent. The symptoms may be, in milder degree, those of either heat stroke or of heat exhaustion. In some the temperature regulating mechanism is not effective, and the temperature actually rises. In others the symptoms are due to the readjustments that are being made to counteract overheating.

Among the symptoms of overheating are a feeling of physical inertia, the result of the relaxation of the muscles to limit heat production. The ability to do physical work is not actually decreased, however, as muscle power may be voluntarily used as usual.

Similarly, mental inertia may result from the relative anemia of the brain that exists when much blood has gone to the skin for cooling. In many persons the ability to do mental work appears not to be hampered by minor changes in cerebral circulation.

When it is necessary for the body to adjust to external heat the digestive tract, too, may be allowed to get along with a very restricted blood supply. Symptoms of indigestion may occur unless a protective lack of appetite limits the intake to simple and easily digested foods. In infants, overheating may be a factor in intestinal disorders, a common cause of infant death.

Although moderate overheating may not harm well adults, in general it has a somewhat depressing effect on all vital processes if long continued, and requires modification of activities.

Fever.

Fever is a derangement of temperature regulation, brought on usually by infection. It may occur in other circumstances—for example, after a severe burn, or an extensive wound.

It is only within the past fifty years that physicians became convinced of the fact that fever is a result of disease, and not a disease in itself. The study of fever was greatly advanced by the invention of the small clinical thermometer for mouth use in 1868. Before then thermometers were ten inches long and it took five minutes to half an hour in the armpit for them to register. Even in hospitals they were not much in use, although the earliest use of them dates back to 1625.

At the onset of a fever, the blood vessels in the skin contract, giving chilly sensations. The coolness of the skin may even excite shivering, even though the interior of the body is warm. Some infections, notably pneumonia, are regularly ushered in by one or more chills. A profound infection of some sort should always be suspected when the body undergoes a "shaking chill."

Shortly after the onset of a fever, the skin becomes warm, dry and flushed, and the mucous membranes become hot and dry, exciting thirst. The rate of respiration and pulse is increased.

Fever is a protective mechanism in infection. It appears that it serves the useful function of weakening the invading germs, increasing the activity of the reticulo-endothelial system and thereby

promoting phagocytosis, and increasing the rate at which immune bodies are produced. Also, it changes certain physiological functions in such a way as to be of assistance—for example, the increased rate of heart and respiration mobilizes the body's forces more rapidly.

Obviously, it is not desirable to dose one's self with medicines to reduce a fever. To lower the temperature not only deprives the body of the benefit of the fever, but also the drop in temperature may be wrongly interpreted as meaning that the illness is over, causing a person to go out while he is still ill. That is the chief objection to taking aspirin for a cold.

Many of the changes that take place in the body during fever are, however, potentially harmful unless they are counteracted. It is necessary to *stay in bed* during fever, to avoid further increase of an already greatly increased metabolism. Also, it is necessary to *take plenty of fluid*, in order to promote excretion. During fever, protein substances in protoplasm undergo the greatest catabolism, and albumen and other nitrogenous substances appear in the urine. At the same time, more fluid than usual is retained in the tissues. Therefore the urine becomes concentrated and wastes may be retained unless the fluid intake is greater than usual. Finally, *plenty of food*, of a nutritious and easily digestible sort, is required, to offset the losses due to increased metabolism. Wasting occurs in prolonged fevers if the diet is not adequate.

Fever Therapy.

Rufus of Ephesus long ago in antiquity noted the value of fever. He said that it should not be combated "because it is a great remedy and it could only be wished that it could be artificially induced." In modern times his theory has been sustained and his hope realized.

Artificial fever can safely be induced by injection of foreign protein; by infection with organisms such as those of malaria; by electric currents; and by hot, humid environmental air. The maximum temperature employed is 107° F. The beneficial effects are those of fever from natural causes. This form of treatment is especially successful in syphilis, since the thermal death time of the spirochete is well within the range of the safe temperatures. Fever therapy is successful however, in a number of diseases.

OVERCOOLING

Freezing.

An ordinarily well person in proper condition can be exposed to very low temperatures even for a long time without suffering harm from it.

Freezing of the *body as a whole* is not common except in those who become unable to move while exposed to extreme cold, as after a disabling accident; or while unconscious, as during alcoholic intoxication. It is reported that one-fourth of those in this country who freeze to death are under the influence of alcohol, and nearly all the others have been victims of accidents. Two-thirds of the total are over 50 years of age. Freezing causes only one-ninth as many deaths as does excessive heat.

For the victim of long exposure to extreme cold, warming should not be too rapid. While transferring such a person to a house or hospital, he should be well wrapped, but upon taking him indoors he should be put in a cool room, if unconscious. If breathing has stopped, artificial respiration should be begun at the earliest possible moment. After the victim has begun to revive, room temperature may be gradually increased. Those who are merely severely chilled may be warmed rapidly, and should receive hot drinks.

The remedy for *local* freezing is also gradual warming, beginning with warmth at the temperature of the body, but without rubbing. Frostbitten areas should not be exposed to open fires, radiators or the like.

Chilling.

Chilling consists of a drop in body temperature, which may be either diffuse throughout the body, or local. General chilling less often occurs in those who keep in motion, maintaining their heat production, than in those who are inactive in the cold.

When quiet, any conditions that favor too rapid and pronounced cooling by either transfer or evaporation may lead to chilling. It is particularly likely to occur (*a*) when the body has become much over-heated (from external warmth or from clothing) and then is too rapidly cooled; (*b*) when the surface of the body is damp (either from rain or snow or from perspiration) and the dampness is allowed to evaporate too rapidly; (*c*) when the body remains for a long time in contact with a medium cooler than itself (cold air, cold water, cold ground, etc.) to which medium the body heat is transferred by conduction; (*d*) when the body is exposed to a strong current of air, either when insufficiently clad or when damp.

It appears that chilling is more likely to occur at temperatures that are moderately rather than extremely cold, for the latter are so uncomfortable as to give warning. At 60–65° F., just below the optimum temperature, is a zone of special danger for prolonged exposure while quiet.

The danger in lowering body temperature is largely due to the associated internal congestion which occurs when much blood has flowed from the surface to the interior of the body. When the organs are congested, their function is likely to be disturbed and they also become more susceptible to infection. Any organs, especially the lungs, the kidneys, and the female reproductive organs, may be disordered as a result of chilling. Undoubtedly much illness is due to exposure to cold to which the body is unable to react protectively.

Local Chilling.

It is particularly difficult for the body's thermostat to govern the distribution of blood as between the exterior and the interior, so as to keep the interior at an even warm temperature when one region of the body needs warming, and the rest, cooling. In fact, it often fails to do this, and the part that needs to be warmed remains cool.

If the temperature of the part which is exposed to the cold actually goes below normal, the condition is known as local chilling. In extreme cases, local chilling results in freezing (e.g., of the fingers, toes, nose, ears), but in less extreme cases congestion may occur in organs underlying the chilled area.

Such congestion may be followed by inflammation and possibly infection. For example, an ear abscess may occur after chilling of the head, as by going out into a cool breeze with the hair damp; or an attack of lumbago (pain in muscles of the back) after sitting with a breeze from an electric fan blowing on the back; or facial paralysis, while lying at night in a cold draft.

The difficulty in such cases as those mentioned is the *inequality* of the temperature around the body. The head, the back of the neck, the back and the feet seem most susceptible to local chilling.

In some cases, local chilling so disturbs the temperature regulating mechanism that remote parts are affected, as in the case of menstrual disturbances following wet feet.

To counteract local chilling, the chilled part itself must be warmed as soon as possible. Measures to counteract general chilling should also be used.

Cold Allergy.

Some of those who do not respond well to cold are allergic to it. In such cases circulatory collapse may follow a plunge into cold water. It is thought that drowning has resulted from this cause. For those who are only mildly sensitive to cold, desensitization may sometimes be accomplished by holding the hands in water at 50° F.

one or two minutes two or three times a day for three or four weeks. For pronounced sensitivity, other methods of desensitization are available.

Subnormal Temperature.

Following an illness with fever the temperature is likely to be subnormal for a time, because of disorder of the overworked thermostatic system. In such cases, the tendency to perspire readily may continue, and the body be especially subject to chilling on slight exposure. Subnormal temperature is not common in other circumstances except in the feeble and undernourished, in which case temperature may be normal except in the morning. When constantly subnormal, an endocrine disorder—subject to treatment—may be the cause.

Refrigeration Therapy.

Not for many years after fever therapy was shown to be successful in the treatment of certain diseases was an attempt made to discover whether overcooling of the body would also be beneficial. Refrigeration has long been used as an anesthetic for operations on cold-blooded animals, but not until 1939 was it discovered that humans can survive a sort of cold hibernation for several days. Although attempted for therapeutic purposes, the method is still in the experimental stage, and has not yet been found to be curative of any disease.

Voluntary Aids to Temperature Regulation.

Within limits, automatic regulation of body temperature is effective. However, it cannot be relied upon completely.

Voluntary efforts must be made in every day life to render assistance to the body in its reflex efforts to prevent overheating and overcooling. Such efforts should be directed not only toward the final result—that of keeping the temperature normal—but also toward attaining that result without too great strain of the functions whereby it is accomplished.

The various aids to maintaining stable body temperature have been mentioned elsewhere. They include such matters as variation in the amount and kind of clothing, food, exercise and baths; the regulation of indoor climate; and training in adaptation to climatic changes.

Chapter 33

SUNLIGHT

The complete dependence of all living things upon the sun is primarily a matter of its influence upon plant growth, whereby combustible materials are produced, that may be burned to give heat and other forms of energy.

It is because of the action of sunlight during past centuries that the earth is stored with such substances as coal and oil, which are used as fuel for heating purposes and to run all sorts of machines. And it is because of the action of sunlight from year to year that plants are able to form their own substance from materials in soil and water and air, and become combustible fuel that animals use as food.

Man uses plants and animals as his food, and from these sources derives a supply of sun-energy which he uses in carrying on all life processes.

As long as the sun shines, providing the earth with warmth and its creatures with sustenance, the individual human can survive if the sun does not shine directly upon him. Nevertheless, he will not get along as well as he would if he himself were directly exposed to its rays from time to time.

In this chapter, the effects of direct exposure of the human to sunlight is the topic under discussion.

The Sun in Primitive Religion.

Probably the most striking natural phenomenon is the rising, the glowing and the setting of the sun. It is not suprising that man in antiquity was inclined to look upon the sun with reverence and awe, and, when he noted its effect on nature's fertility and his own prosperity, to worship it.

The first deity that was not a tribal or national one was Aton-Ra, whom the early Egyptians worshipped. Ahknaton, the first Pharaoh, founded the religion of which the symbol was the sun and its life-giving essence, and he coined his own name to mean "son of the Sun."

The primitive gods of other peoples were also looked upon as the personification of the sun, and there were temples to sun-gods in the early days in many lands.

The ancient Assyrians worshipped Shamash as their sun-god; the Japanese, a sun-goddess Tiayo, from whom they believed all their mikados were descended; the Persians, Baal; the Philistines, Mithras. Among the Greeks, Helios was the sun-god. He was represented as driving a four-horse chariot through the heavens. It is from the name of this sun-god that several words are derived (e.g. heliotherapy, or treatment by sun rays).

FIG. 133.—Ancient Egyptian bas-relief, showing Ikhnaton and his wife, Nefteriti, giving their three infant girls a sun bath. (American Journal of Diseases of Children.)

Ancient Medicine and the Sun.

Just as the sun was of importance in early religion, so also was it of importance in the early art of medicine. Its rays have been used for healing from the earliest recorded history of mankind.

Pliny (23–79 A.D.) said "Sol est remediorum maximum" (the sun is the greatest of all remedies). He was voicing the idea of his times and of times long before his.

In Hindu writings thousands of years old, it was stated that the sun's rays could "restore vigor to the muscles and brighten the intellect of the elderly."

Among the ancient Egyptians, Greeks and Romans, sunlight was looked upon not only as a remedy but as a preventive of many

ills, and as a promoter of the well-being of the well. For example, the citizens of Pompeii, a thousand years B.C., demanded and received money from the city to compensate them for having their sunlight cut off when the city wall was built.

Doctors in the old days prescribed sunlight for almost all diseases. Herodotus (431 B.C.) said that they considered light "as a means of repelling illness and as an aid in treating it." Hippocrates, the Father of Medicine, used the sun-cure in the Temple of Aesculapius and elsewhere on the islands of Greece.

During the Dark Ages, the health-giving value of sunlight was forgotten. Most cities were dark, enclosed in walls; and houses were dark, having only windows without glass, and covered by boards to keep out the cold during a greater part of the year. Undoubtedly the plagues of those times were made worse by such conditions as these.

Gradually, however, man began to learn anew the value of sunlight, and this time with scientific discoveries to back up everyday observation. Rarely has ancient medical lore been as fully substantiated as has that regarding sunlight.

Modern Investigations of Sunlight.

Sir Isaac Newton made the first discovery of importance in regard to the sun. In 1666 he discovered the visible spectrum, with the colors from red to violet. From then until 1800, little more was learned about the sun, but in that year Herschel announced the apparently contradictory fact that there is light that is invisible. Furthermore, he proved to the astounded scientific world that there actually were invisible rays beyond the red rays of the spectrum (infra-red rays). The next year, Ritter announced that there were also invisible violet rays (ultra-violet).

From that time on, one discovery followed another, until now we are living in a world tremendously enriched by our understanding and use of invisible light waves.

Light Waves.

Light travels to the earth from the sun in electromagnetic rays. Although portrayed traditionally as straight, the rays comes in waves or pulsations. They vary in amplitude and follow each other in varying frequency. A rather poor simile, but a helpful one, is to be found in the ocean, whose waves consist of enormous billows or small ripples, following each other either slowly or rapidly. The amplitude of a wave is the swing of the wave above and below

an imaginary midpoint called zero; and the wavelength is the distance between the crests of the waves.

The wavelength of visible light varies from 0.00039 to 0.00076 millimeters. The speed of light rays is always the same—that is, they travel at the rate of approximately 186,300 miles per second. (It takes 8 minutes and 20 seconds for light to come from the sun to the earth.) The frequency of rays is, naturally, the velocity divided by the wavelength.

The Spectrum.

The electromagnetic vibrations known as light form part of a complete series, as shown in Fig. 134. The shaded area about midway of the black column is the range of visible light rays. They comprise "white light" which, when passed through a prism, splits up into seven colors. These are known as the colors of the spectrum, and are seen together in nature in the rainbow. Of these visible rays, the red have the longest wave length and the violet the shortest. Both are measured in Angstrom units, or in ten-millionths of a millimeter.

Beyond both ends of the visible spectrum are light rays that are *invisible*. Beyond the red end of the spectrum are the invisible infra-red (or heat) rays. Still longer are the radio waves. Rays 30,000 meters long have been used in radiotelegraphy.

Beyond the violet end of the visible spectrum are the still shorter ultraviolet rays. These are invisible, cold rays of great potency. They are known as actinic or chemical rays, because they excite chemical action in substances that absorb them. They were first discovered because of this property. Beyond the ultraviolet rays are the Roentgen or X-rays, and the alpha and gamma rays from radium (natural, or produced by the atom-smashing cyclotron) which are the shortest known to science.

The ultraviolet rays are the most important from the point of view of general health, and will be discussed after brief comment upon visible and infra-red rays.

Visible Rays.

The visible rays of the sun provide illumination. Whatever benefits they confer upon health are exclusively the result of illumination. However, illumination itself appears to be stimulating to the body—perhaps through the cheering effect on the "spirits." A dark house is usually called a gloomy house. Depression of mind is

Complete Electric Wave Spectrum

Kind of Waves	Octaves	Approximate wave length	Approx. Frequency	Usual source. Hypothetical in some cases	Usual method of detection
Cosmic Rays?	?	?	?	Source unknown, probably beyond the Milky Way.	By penetrating and ionizing power
		1×10^{-10} cm.	3×10^{20}		Fluorescence
Gamma Rays	6.6	5×10^{-10} cm.	6×10^{19}	Atomic explosions	Chemical effect Ionization
		1×10^{-8} cm.	3×10^{18}		Fluorescence
X-Rays	14.3	1×10^{-7} cm.	3×10^{17}	Cathode Ray Impacts causing orbital shifts of inner shell electrons	Chemical effect Ionization
		1×10^{-5} cm.	3×10^{15}		
Ultra-Violet (Chemical)	8.6			Disturbances of intermediate Electrons	Fluorescence Chemical effect
Light	1	39×10^{-6} cm. 78×10^{-6} cm.	77×10^{13} 38×10^{13}	Disturbances of Valence Electrons	Eye Chemical effect
Infra-red (Heat)	9			Disturbances of Atoms and Molecules	Heating effect Thermopile Bolometer Radiometer Radio-micrometer
		3×10^{-2} cm.	1×10^{12}		
Short Electric	13			Short Oscillations High Frequency Discharges	Electrical Resonance
Radio Broadcasting Band	1.5	199.5 meters 545.1 meters	1500 K.C. 550 K.C.	Antenna or loop oscillators	Electrical resonance in tuned circuits
Radio Long Electric	?			Circuits including large capacities and Inductances Alternating currents	Electrical resonance Electro-magnetic Induction Oscillographs
?		∞	0		

FIG. 134.—(Foley "College Physics.")

common in those parts of the world where nights are long and days short.

Artificial illumination serves admirably as a substitute for visible sun rays. However, in houses it is more economical, more convenient, and perhaps easier on the eyes to use natural sunlight for daytime illumination.

A secondary advantage of a flood of natural sunlight in a house is that it reveals very clearly any dirt or disorder. A sunny house is likely to be a clean house; and a clean house is an important advantage to bodily and mental health.

Infra-red Rays.

These are the heat rays, which cause sunlight to be warming. The amount of heat released yearly by the sun is equal to the burning of a mass of coal sixty times the size of the earth. It is estimated (Russell) that the sun will continue to heat and light the world for at least another billion years.

These rays are also given off from any heated object, especially those heated "red hot" or to incandescence. The ordinary electric light bulb gives off 85–98% infra-red rays. A problem in physics, recently solved, has been to make electric light bulbs that would give off more light and less heat.

Infra-red rays penetrate the interior of the body, and as they pass through the skin they may burn it. The shorter they are the less they burn. The infra-red rays of the sun are short ones, and therefore warm the body "to the marrow," without burning it. At most they may redden it. The longer infra-red rays—for example, from a hot stove—burn before they have a chance to penetrate far.

Because of the penetrating power of the infra-red rays, they may be used as medical treatment where heat is needed in the interior of the body—as for example to relieve congestion and inflammations of some sorts. Physicians often prescribed them for some kinds of muscle and joint inflammation. Still longer wavelengths (e.g. short radio waves) are still more powerful sources of penetrating heat.

In everyday life, the effect of the sun's infra-red rays is good or bad for health, according as one needs to be warmed or cooled. The effect of heat on the body is discussed in Chapter 32.

ULTRAVIOLET RAYS

History of Ultraviolet Rays.

It was nearly a hundred years after ultraviolet rays were discovered by Ritter before they were put to any sort of practical use

for health. The credit for discovering their important effect on the body goes to Niels Finsen, a Danish physician, generally recognized as the founder of phototherapy. The year before, in 1892, Peter Cooper Hewitt, an American electrical engineer, had found a way to make ultraviolet rays artificially. Finsen in 1893 devised another method, and, still more important, he thought of trying their effect on certain skin diseases known to be helped by natural sunlight. He found ultraviolet rays effective in curing these diseases, and announced that fact to the medical world. Also, he formulated the theory that it is the ultraviolet rays which are chiefly responsible for the beneficial effect of sunlight upon the body. For this discovery, Finsen was awarded the Nobel prize for medicine in 1904.

Through the influence of the Queen of England, phototherapy was first established in a hospital in 1905 (the London Hospital). This marked the first scientific use of the sun's rays in medicine.

Encouraged by the successful use of artificial sunlight, two Swiss physicians began experimenting in treating disease by natural sunlight. Bernhard used it in 1902 for surgical wounds, and Rollier in 1903 for tuberculosis of the bones or the joints. The latter established a large sanatorium in the Alps at Leysin. It is from him that science learned most about how to use natural sunlight. His method, of gradually increasing exposure of the nearly unclad body, has been adopted the world over.

At the present time, ultraviolet rays both from natural and artificial sources are widely used both for preventive and curative purposes.

The Effect of Ultraviolet Rays.

The extraordinary power of ultraviolet rays is due to the fact that they excite chemical action in substances that absorb them. Photography is based upon this action. The sensitive film or plate of a camera, and the paper on which photographs are printed, accurately record exactly where and to what extent the ultraviolet rays fall upon them. The brighter the sunlight (i.e. the stronger the ultraviolet radiation) the better the photograph. It is for this reason that Southern California has become the moving picture center in this country.

The human body contains chemicals that are sensitive to these actinic or chemical rays of the sun. Some tissues are particularly so, and probably all tissues are so to some extent.

In the next few sections, three well-known effects of ultraviolet rays will be mentioned—their effect upon *normal growth* and *tissue*

vitality; their *stimulation* of the body and its functions in general; and their *action against bacteria.*

GROWTH AND TISSUE VITALITY

Vitamin D and the Bones and Teeth.

In the body of man and of animals, ultraviolet rays are absorbed by the skin, and activate fatty substances, called sterols, to produce vitamin D. The skin acts as a storage place for vitamin D, whence it is given off to the body a little at a time until the supply is exhausted.

Although vitamin D is important for an adult, it is absolutely essential for the bones and teeth during the growing period of infancy and childhood. Without it a crippling disease called rickets (rachitis) occurs.

Prevention of this disease is through exposure to sunlight. Natural foods do not contain enough vitamin D to protect a child from it. If a child receives enough sunlight in the summer, he may, however, store enough to protect him during the winter, with the small amount he obtains in winter from sun and food. But in many climates the year around supplementary supplies of vitamin D are necessary and are usually given in the form of fish liver oil with, perhaps, irradiated foods as well.

Both sunlight and codliver oil were used many centuries ago for the same purpose as now, but it was not until 1924 that Hess of New York and Steenbock of Wisconsin showed why they both have the same effect. Experimental work with animals showed that rickets could be caused by the lack of either, and prevented by the use of either in sufficient quantities.

Other Tissues.

In general, the tissues of those who are exposed to plenty of outdoor sunlight seem to be in better condition than of those on whom the ultraviolet rays seldom fall. This is evidenced, for example, in the quality of the blood. A deficiency of red cells, and of hemoglobin in red cells, as in the common type of anemia, may often be greatly improved by due exposure to ultraviolet rays.

Also, sunlight has a good effect upon the tone and the agility of the muscles. With an increasing coat of tan there often appears an increasing firmness of the muscles. The same increase of tone seems to be produced in the involuntary muscles as well, such as those in the intestinal tract, and even the heart.

The effect of sunlight in bringing the tone of the skin to normal is traditional. This and other effects of ultraviolet light upon the skin are discussed on later pages.

STIMULATING EFFECT

In general, ultraviolet rays seem to have a tonic effect upon the whole body, especially, perhaps, on the nervous system. The subjective effects of sunlight in the right amounts are generally described as a sense of well-being and buoyancy. After a series of sunbaths, the mood may improve for the better, and the quality of mental activity. Often there will come increased ease and pleasure in the daily work and play, and sounder and more refreshing sleep at night.

There is another side to the story, however. For most people there is a limit to the amount of stimulation that is beneficial, and beyond that limit stimulation may proceed to exhaustion. Some feel fatigued, rather than exhilerated, and sleep less soundly instead of more so, after a long sunbath, or a series of them. Not infrequently a sun-fanatic returns from a vacation in a state of irritability bordering on a "nervous breakdown."

Some of the symptoms that often follow too much sunning may be ascribed to the heat rays (see heat stroke, Chapter 32). But frequently it is the actinic rays that are responsible for such symptoms as headache, nausea, dizziness, and weariness after too long a sunning. After the right amount of sunning, there should be no unpleasant effects at all.

The term heliophobe is applied to those who are unusually affected by sunlight. Blondes are by nature to some extent heliophobes. On account of their thin white skin they receive more ultraviolet in a given length of time.

It is possible, however, for any person to acquire photosensitivity. This may be either temporary or permanent, and may be due to allergy or other chemical conditions in the body (e.g. presence of sulfanilamide, or some other drug), or to disease.

A few of the disease conditions in which sunlight may be seriously harmful are: diabetes, lung tuberculosis, arteriosclerosis, and pronounced states of nervousness. It would be safer for any person who is ill to find out what effect sun would be likely to have upon him before he begins any unusual exposure to it.

Care must also be used in the case of infants and the elderly. Too much sun harms infants as much as the right amount benefits them.

Because of the possible effect upon the brain and the sex glands, it is recommended that a head covering and a loin cloth be worn during all sunbaths.

BACTERICIDAL EFFECT

Disinfection.

Ultraviolet rays kill bacteria on *surfaces*. Natural sunlight is valuable in the disinfection of a room in which an infection has been cared for. Artificial ultraviolet is used for the protection of meat and other foods while in storage; and for the disinfection of surfaces in hospital operating rooms. As has been mentioned, certain diseases of the skin in which bacteria are present on the surfaces are treated by natural or artificial sunlight.

Although ultraviolet rays do not penetrate beneath the surface of most substances, they may be used to sterilize *water* since they pass through it if it is perfectly clear and transparent. They would be the ideal disinfecting agent for water if the method were not so expensive. In spite of the cost, they are used for that purpose in some swimming pools. A thin sheet of water flows continuously over and under lamps giving off the rays. Also, they are used in the same way by some manufacturers of bottled beverages.

The possibility of sterilization of *air* by ultraviolet rays has only recently begun to attract interest. To do so without exposing the occupants of a room to irradiation is rather difficult. As yet, the most practical use of ultraviolet in air sterilization has been in hospitals. To prevent germs from either entering or leaving a sick room, an ultraviolet lamp is placed above a doorway, so that its light falls across it like a curtain.

Increased Resistance to Infection.

When a germ disease is benefited by exposure to ultraviolet light, it appears to be due to an improved condition in the body which enables it to cope with the infection. This does not occur in all germ diseases, however, nor at all stages of infection. Sunlight may indeed activate early lung tuberculosis or a "grumbling" appendix.

In many cases, after a series of irradiations (to natural or artificial sunlight) there will be an increase of white corpuscles in the blood. To the extent to which white corpuscles aid in overcoming infection, this is an advantage.

It is justifiable for the normal person to feel that his normal exposure to sunlight does do something to keep his tissue resistance normal. As for the treatment of an existing infection, that should be a matter for the physician to decide.

To the extent that chilling of the body is a factor in infection, sunlight may increase resistance by making a person less suscep-

tible to chilling. That judicious sunbathing may have that effect has been noticed by its devotees, including Benjamin Franklin and Walt Whitman, and has been confirmed scientifically.

EFFECT UPON THE SKIN

Tanning.

Upon exposure to sunlight, certain cells in the skin that produce a brown pigment, called melanin, increase their activity. All but albinos have some of these cells. In brunettes they are usually diffuse all over the body. In blondes and red blondes they are scarce, and may be present in clumps, so that tan appears as freckles.

The effect of melanin is to make the skin more opaque, and therefore less able to absorb ultraviolet rays. This melanin barrier is a valuable safety device for those who are out a great deal. The more exposure, the more tan, and the less danger of overdosage of ultraviolet.

Whereas a heavy coat of tan protects from harm, it also limits the amount of benefit from further exposure. A dark skinned child, who may be considered as born tanned, requires much more sunlight than a light skinned one, if it is to escape rickets.

Obviously, some degree of tanning is desirable but not so much as to shut one off too completely from the sun. Also, it is clear that the degree of tan is not a measure of the amount of ultraviolet one has received. The blonde may have received as much through his uncolored skin by sitting in reflected sunlight under a tree and remaining white, as the brunette while lying in direct sunlight, becoming browner and browner. It is even possible for a child to obtain the large amount of ultraviolet necessary to cure him of rickets, without ever becoming tanned.

As for the skin itself, tan protects it as much as it does the rest of the body. Exposure to sunlight should be governed by the rate at which tan can form. Sunburn should never be permitted to occur, in blonde or brunette. It is evidence of overdosage of sunlight, and is bad for the skin.

For the untanned skin that is capable of tanning, the following schedule is appropriate when beginning sunbaths in summer:

First day: 5 min. before 10 a.m. (standard time) and after 4 p.m.
Second day: 10 min. before 10 a.m. and after 4 p.m.
Third day: 15 min. before 10 a.m. and after 4 p.m.
Fourth day: 20 min. before 11 a.m. and after 3 p.m.
Fifth day: 25 min. before 11 a.m. and after 3 p.m.
Sixth day: 30 min. before 11 a.m. and after 3 p.m.

By the seventh day, if one's skin is capable of it, a light coat of tan will have appeared, and less caution will be necessary. If exposure is begun in the spring, scarcely any precautions are necessary, for the strength of the ultraviolet rays varies according to the season. In summer they are 1,000 times as strong as in winter.

The blonde may be unable to proceed with this schedule beyond the amount of sunning specified for the first or second day, but if he continues with these short exposures he is likely to derive as much benefit from them as the dark skinned person does from longer exposure.

In Dr. Rollier's sanatorium, the procedure is to expose only the feet at first, three times for five minutes, working up to three hours (divided between front and back of the body) at the end of two weeks.

The process of tanning cannot be hastened by those who have only a short time in which to mark themselves as returned vacationists. Ointments and the like may perhaps make burning less likely, but they do not cause tan to develop. It might be added, too, that none cause it to disappear.

Sunburn.

Sunburn is to be avoided. It never helps the skin, and may do it great harm. A severe sunburn is like any other burn—dangerous to life if it covers one-third of the body.

Aside from the harm of the burn itself, associated maladies—such as pimples, "cold sores" and even, in some cases, more serious skin infections, such as erysipelas—may appear.

To prevent sunburn, no method is equal to that of avoiding too long exposure to strong ultraviolet rays.

It is important to realize, first, that ultraviolet rays *are not hot rays*. They burn, but do not warm. They may reach the body in burning strength even on a day when the sky is somewhat "overcast," and the skin does not feel at all warm.

Second, it should be realized that the burns by ultraviolet rays *do not appear at once*. It is impossible, by the immediate sense of warmth in the skin or by its redness at the time, to know how much one has burned. The redness from heat rays appears at once, but the later sunburn may be entirely out of proportion to the heat felt during exposure. If a person remains in the sun until his skin is red, he may have remained there much too long.

Third, ultraviolet rays *reflected* from water, white sand, snow or ice reach the body with intensified force. Sunburn may occur even in winter at a high altitude where ultraviolet rays are stronger and ice and snow prevail. This fact was early discovered at Dr. Rollier's sanatorium in the Alps. At the winter resort, St. Moritz, skaters carry parasols to prevent sunburn.

As for applications or creams to *prevent* burning, none seem to be so brilliantly successful that they can be relied upon to counteract rash exposure. Possibly the use of vanishing creams are of some assistance. Most oily substances are not recommended.

To *treat* sunburn, if mild, the ordinary vanishing creams, which contain stearates, are often soothing, especially if they also contain menthol. Tannic acid in the form of weak tea, or in a tannic acid jelly, is useful. These stain clothing, but not the skin.

For severe sunburn, medical care is needed. Pending that, one may lie in a tub of water at body temperature containing two tablespoonfuls of baking soda to the gallon.

Even the slightest burn is likely to cause itching and peeling. Until that is over, it is better to leave the skin alone except for very gentle washing. The flakes should be left in place until they fall off, in order to protect the more tender skin beneath. Blisters should receive medical attention.

Even after only one severe burn, the skin may never be the same again. The following facts are interesting as an account of what happened in the case of one young man carefully observed after a single one-hour exposure of previously untanned skin to midday sun in August.

Redness appeared in two hours and was at its height in eleven hours. Tests showed that there was stagnation of the blood in the area exposed, and this persisted for four and a half months. An increase in melanin came in two days, was at its height in 19 days, and began to diminish in 30 days. But another pigment, melanoid, succeeded it, and was at its height at four months. At the end of nine and a half months the skin was darker than before exposure (43.6% relative brightness, as against 48.6% before exposure) although the melanin and melanoid had faded, the darkness being due to congestion of blood vessels.

The Over-sunned Skin.

Although a moderate amount of sunlight, without burning, is in most cases good for the skin, an excess may be bad for it, even though one has never burned.

Those whose work or play keeps them in sunlight a great deal often develop a somewhat thickened and leathery skin, with enlarged oil ducts, visibly dilated capillaries, especially on the cheeks, wrinkles, and permanent brown spots. Such a condition, with some or all of these symptoms, is known as actinic dermatitis (inflammation of the skin from ultraviolet rays). It is also called "sailor skin," because it often occurs in those who spend much time on the sea and receive large doses of sunlight both direct and reflected from the water.

In lesser degrees, such a condition of the skin is rather common. It takes many women to beauty parlors for expensive "facials" and "packs," which prove disappointing. After the skin has been damaged by sun, and tissue changes have taken place, it cannot be restored to normal. If treatment is to be at all effective, it must be administered by a dermatologist (skin specialist). In this condition, an ounce of prevention, however, is worth a ton of cure.

Abuse of the skin by excessive sunning is one of the things to avoid, on the understanding that any chronic irritation may lead to cancer. The brown spots that remain after tan has faded not infrequently undergo malignant overgrowth. The effect of sunlight in causing skin cancer was recently shown in a report from the Army. Of 542 skin cancers in young men from 20–24 years of age, far more were in southerners than in northerners. But a sun-faddist in any climate can find enough sunlight to harm his skin seriously.

Sunlight and the Eyes.

It is a good thing for the eyes to become accustomed to ordinary outdoor light. Normal eyes usually have little difficulty even in bright sunlight. Nevertheless, because the eyes are sensitive structures, and the membranes and skin around them are delicate tissue, strong sunlight may prove somewhat irritating. This is particularly true in the case of babies. For children and adults it is recommended that a hat with a brim, or some sort of head gear, should be worn to shade the eyes from direct sunlight, especially in the middle of the day, and while engaged in sports or driving, or taking a sunbath. In some of the southern hotels, guests are not allowed on the beach or in the cabanas without a hat and colored glasses.

Although ordinary colored glasses, such as may be purchased almost anywhere for a few cents in the summer, may do no harm to the eyes if worn only while sunbathing, they should not be worn at times when the eyes are being used. They are of imperfect wavy

glass, and distort vision imperceptibly but harmfully. In one state, they are outlawed.

For the use of those whose eyes are especially sensitive to light, or are especially exposed to it, standard guaranteed absorption lenses are available, either "plain" or made up according to an optical prescription. These meet the requirements of the United States Bureau of Standards. The minimum cost for the plain lens is seventy-five cents. Safe colored glasses cannot be bought for less. Polaroid glass is even more effective in preventing glare, but is more expensive.

METHODS OF OBTAINING ULTRAVIOLET RAYS

Variations in Available Sunlight.

It is obvious that the strength of ultraviolet rays varies according to the season, the lattitude, the altitude, and the time of day; and

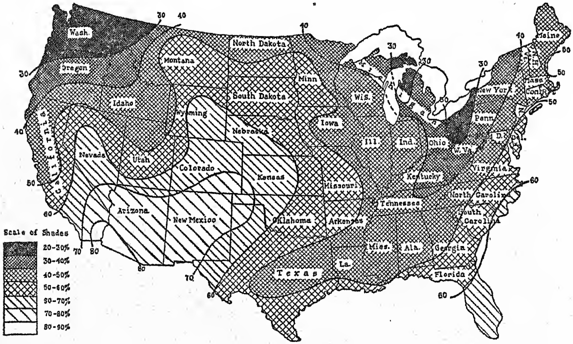


FIG. 135.—Average percentage of actual sunlight in winter. (Courtesy Michigan Division of Public Health.)

that in any given region the proportion of ultraviolet rays varies with the proportion of clear weather. What is not so obvious is that moisture in the air, even on a sunny day, checks the penetration of ultraviolet rays to some extent. Regions with clear, dry atmosphere are best suited to photography and also to radiation of plant and animal life.

Above is a map showing the amount of sunlight in the various parts of the United States in proportion to the amount that would

be possible in those areas. But in order to obtain enough sunlight it is not necessary, usually, to change the abode. In most climates it is chiefly a question of taking advantage of what is available.

For those who keep business hours, daylight saving time may be classed as an important health measure, since it provides an easy way for many people to obtain an extra hour of sunlight. The idea was first advocated by Benjamin Franklin a hundred and fifty years ago; noting that "early to bed, and early to rise" did not seem to appeal to most people, he suggested changing the clocks.

Residents of cities should realize that their supply of sunlight is greatly reduced by much unnecessary smoke, soot, and dust. In one industrial city, not more than 60% of sunlight reaches the street level even at high noon, and still less in the morning. This is a serious situation, especially for babies. In many a city, at no time of the year is there enough natural sunlight to protect them from rickets. For this reason, and for others, anti-smoke campaigns, are more and more being included in public health work. Electrification of railroads and industries would be an ideal solution of this problem.

Clothing.

According to the United States Bureau of Standards, some fabrics permit a portion of the ultraviolet rays to pass through them. They are, in order, rayon, linen, and cotton. But they must be loosely woven, thin, and preferably undyed.

By experiments with photographic paper, putting it inside the clothing, it can easily be seen that the paper will remain uncolored under men's conventional street clothing. Under some sorts of women's clothing, it will be slightly colored. Under summer sports clothing such as both men and women wear in summer, it will be appreciably colored, indicating that such clothing admits an appreciable amount of ultraviolet rays. This suggests that, to obtain as much ultraviolet light as possible, it is well to wear abbreviated sports clothing whenever it is feasible.

Glass.

Ordinary window glass does not admit ultraviolet rays. Transparent fused quartz glass, as used in sun lamps, transmits over 90%. For special purposes—as in children's sanatoriums—several rather expensive kinds of glass are available that admit varying amounts of ultraviolet rays. None of these has as yet been satisfactory in supplying as much ultraviolet light as is necessary to prevent rickets

or to cure bone tuberculosis. Promising experimentation continues, however.

Foods and Medicines.

To obtain one of the benefits of sunlight—that is, a supply of vitamin D—it is not absolutely necessary to be exposed to sunlight. Preformed vitamin D may be taken in natural foods, medicines, and irradiated foods.

Many irradiated foods are on the market, under the patent issued to Steenbock of Wisconsin University. The income from the use of the patent goes to a research fund. Irradiated milk (fresh, evaporated or dried) is the most widely used and the most successful.

Artificial Sunlight.

Using either a mercury vapor or a carbon arc, lamps can be made to give off all the sun's rays or only those of a given wave length. The large ultraviolet lamps in professional use may deliver even stronger ultraviolet rays than the sun itself. These powerful instruments are widely used in the treatment of many ills.

If home treatment by lamps is necessary, medical advice should be obtained regarding the kind of lamp and the dosage.

Chapter 34

ATMOSPHERIC CONDITIONS

A. OUTDOORS

Climate.

The term climate refers to the average course or condition of the weather at a particular place over a period of many years. The term weather refers to the state of the atmosphere with respect to meteorological conditions such as temperature, moisture, wind velocity and the like.

Obviously, weather and climate are among the most important of the environmental factors that affect man. They affect him directly by the changes they make in his body, and indirectly through affecting plant and animal life which he uses for food. Furthermore, since climate and weather are immutable, they require modification in man's behavior, in order for him to take advantage of the beneficial aspects of climate and to avoid its harmful effects.

Montesquieu described climate as the most enduring of all empires. He said "Its dominion is invincible. Its laws must be obeyed. It makes no compromises, and it grants no pardons." Primitive man realized that fact quite well, and his first answer to the immutability of climate was to leave one that was unfavorable and seek a better one.

Among the earliest records of man's history are accounts of the migrations of whole peoples, such as the Graeco-Latins from the region of the Baltic southward to the Mediterranean, with their flocks and their herds in search of lands where the climate was benign and afforded good grazing for animals and thereby food for man. Most of the early centers of civilization appear to have been established almost entirely with reference to climatic conditions—the majority in the warmer climates where vegetation flourished, providing abundant food for man and beast, and where little was needed in the way of shelter from the elements.

Nevertheless, even in the most favorable climates that primitive man could find, the changes of weather from day to day and year to

year did present problems, and these stirred man's ingenuity and established many of his customs such as tilling the soil and irrigating it and growing agricultural crops that could be stored against lean seasons, building houses for his own shelter and that of his herds and his crops, and wearing clothing.

All these efforts toward self-preservation against the hazards of climate helped man's development as *homo sapiens*. It seems that climate has been the most important agency in teaching man the necessity of learning to modify his habits, and of working intelligently for his own survival.

Modern Study of Climate.

Although the need for obeying the laws of climate has always been appreciated, it was not until this century that any serious attempts were made to determine precisely what those laws are. From what has already been learned of bioclimatology it appears that the life of nations and of individuals might be greatly improved by fuller study of the effects of atmospheric conditions on living things of the plant and animal kingdom, and a fuller adaptation along scientific lines to prevailing meteorological conditions and their variations.

Among the advances along this line are those of the botanists, who have developed plant ecology to a considerable extent. Ecology is the science that deals with the relationship of living things to their environment. Botanists are studying atmospheric conditions as among the chief environmental factors influencing plant growth.

Also, advances have been made in meteorology, with special reference to the prediction of the weather that will occur in a given region at a given time, which obviously provides the means for numerous protective measures the need of which could not otherwise be anticipated. In ancient times astrological signs and omens were used for the same purpose now served by science.

Physiologists have been very active in studying the nature of man's physiological responses to the various atmospheric conditions. It has been known from time immemorial that man could and did adapt to a wide variety of climates, but just how this was accomplished was not fully understood until this century. As a result of these studies, man is now in a better position than ever before to appreciate that these physiological responses sometimes need aid, and to render the appropriate aid at such times.

It is possible that continuing research along the lines of physiological effects of climate may in the future open new possibilities

in preventive medicine. It is known now that individuals ill with certain diseases do better in dry climates than moist, or in warm climates than cold. More precise information may make possible in the future scientific choice of climate for those who are well, with a view to keeping them well. To date, however, medical climatologists have discovered nothing to overthrow the long-held theory that a well person who lives wisely can thrive in any habitable region—certainly in any region of the United States. However, the qualification *live wisely* is important. While living in the same climate, man can make a "conditional conquest" of it—to use the phrase of Professor Ward of Harvard University—by contriving to protect himself intelligently against its possibly harmful effects.

Main Factors in Climate.

As it affects the human organism, the climate is of major importance in respect to its *temperature*. As stated in Chapter 32, it is essential that the temperature of the human body be kept normal, and the chief difficulty in keeping it normal arises from atmospheric conditions. The adaptation of the body to external heat and cold has been sufficiently discussed. It remains to comment upon two other factors in the atmosphere that complicate the difficulty of losing or of retaining body heat.

a. Moisture.—At high temperatures, loss of excess heat from the body takes place chiefly by evaporation of perspiration, but if the relative humidity is high, as on a day described as muggy, less perspiration can evaporate and less body cooling can take place. The term relative humidity means the relative amount of moisture that the atmosphere contains in proportion to what it could contain at a given temperature.

Obviously, if the atmosphere is nearly saturated with moisture (as at 90% relative humidity), it can take up little more in the form of evaporated perspiration. On a hot humid day, perspiration therefore stands out on the skin until it rolls off, or it remains in the clothing. The body temperature may rise. It is on such days that heat prostrations are most likely to occur.

On the other hand, in cold weather loss of heat by perspiration is not a factor, since perspiration is at a minimum. The chief loss of heat when the external environment is cold is by conduction to the surrounding cold air. Damp air is a better conductor of heat than dry air. Therefore there is danger of too much loss of heat by conduction on a cold damp day, or indeed on any damp day when the

temperature is below the level at which perspiration becomes an important factor in loss of heat (i.e., at 70–80° F.).

Obviously, dampness in the air gives hot air a hotter effect, and cold air a colder effect. Therefore, a comparatively dry climate is more favorable than a moist one at all temperatures. This is true even of extreme dryness combined with extreme heat, as in desert regions.

b. Motion.—A current of air increases the rate of evaporation of perspiration and also it blows away the warm blanket of air that

Fig. 136.—The winds blowing at a city. According to medieval ideas a city had to have a particular location in order to be healthy. (After Louffenberg: Versehung des Leibes. 1491.) (Courtesy of Ciba Symposia.)

collects next to the skin under the clothing and in the folds of the clothing; it is therefore an advantage in hot weather and a disadvantage in cold weather. However, a completely still atmosphere even in cold weather has its disadvantages, one of which is that it fails to arouse the sensory impulses that start protective reactions. A slight breeze on a cold day causes one to realize how cold the temperature is and to take the necessary measures to prevent being frost bitten.

The Most Favorable Atmospheric Conditions.

It is generally thought that the conditions to which it is easiest to adapt, and which most people find most comfortable are: temperature from 68–72° F.; relative humidity not much below 50%

nor much above 65%; and wind velocity from 1 to 3 miles per hour, which gives a gentle but perceptible breeze.

Quite different conditions prevail on nearly every day in the year in nearly all regions in the temperate climate, and yet the temperate climate with all its variety is thought to be the most favorable for man's health and activity. Apparently for many people, an "ideal" climate such as that mentioned is neither necessary nor desirable—in other words, is not ideal except for the delicate.

The Temperate Climate.

The advantages of the temperate climate were noted in the 4th century B.C. by Hippocrates. In his treatise "On Airs, Waters and Places" he said "To develop vigor and bravery, a climate is needed which will excite the mind, ruffle the temper and demand fortitude and exertion." Centuries later, Guyot, the American geographer who perfected the system of meteorological observations from which the present Weather Bureau of the United States was derived, said, "In the temperate climate all is activity, movement. The alternations of heat and cold, the changes of the seasons, a fresher and more bracing air, incite man to a constant struggle, to forethought, to the vigorous employment of all his faculties."

Briefly, the temperate climate may be described as stimulating, and it is believed that this stimulation is better for the average human than a more sedative climate. Clearly civilization has advanced more rapidly in the temperate climate than in those that are steadily either hotter or colder.

Climatic Stimulation.

The bracing effect of the temperate climate is to a considerable extent related to the changes of temperature, and especially to the frequent recurrence of cool or cold days. When the external temperature drops, heat loss takes place, metabolism is stimulated, and more heat and energy are available.

It is thought that cold is stimulating largely because of its effect upon the adrenal glands. These glands, it will be recalled, respond to the need for more heat in the body by increasing the rate of heat production and bringing about various circulatory changes, through stimulation of the sympathetic nerves, so as to prevent undue heat loss.

At the same time, other functions of the adrenal gland appear to be stimulated also. The total effect of stimulation by cold is much the same as occurs when the adrenal glands prepare the whole system for extra exertion such as a fight or an athletic competition; the body's forces are mobilized for action.

Those who live constantly in a cold climate become more or less acclimated—that is, they adjust more or less completely to normal physiological function at a lower temperature level. The fact that they do not exhibit the same energy as those in variable climates is attributed to the fact that they must use much of their energy as heat to keep warm, and have less to turn into other energy channels.

Conversely, in monotonously warm climates, lower rates of metabolism, and of energy production and use, prevail. Individuals tend to become lethargic rather than energetic. If heat loss is difficult, metabolism is reduced to its lowest ebb, less energy is available, and all of the body processes are to some extent depressed. However, those who are adapted to easy loss of heat may suffer comparatively little impairment in either mental or physical activity after they become acclimated.

The effect of the thyroid gland upon adaptation to external temperature was mentioned on page 518.

Outdoor Life.

Clearly, to obtain the full benefit of *climatic stimulation* it is necessary to be actually out in the open air where the stimulating factors prevail. In all seasons, outdoor air is usually cooler and in greater motion than indoor air, and on that account is more stimulating. Therefore, it is to be recommended that every person spend at least a part of every day outdoors. For many, that dictum of hygiene is one of the pleasantest to follow; "life begins" for them when they are in the open.

At most seasons of the year, being out of doors means also being in motion, and at least a part of the benefit of outdoor life is due to the *physical exercise* that accompanies it. Yet even when inactive outdoors, the same stimulating effect of coolness and air motion is felt. For example, a person swathed in rugs lying in a chair on the deck of a steamer may be appreciably stimulated by the cool breezes that reach only his face. In a good many hospitals, patients wrapped up in bed are rolled out on to a veranda, for even the small amount of stimulation obtainable in that way may make a difference in their convalescence. This fact was first noted by Dr. Benjamin Rush, a physician of the time of George Washington; he had sick soldiers moved into sheds in an orchard, and on clear days under the apple trees, and stated that they "recovered with astonishing rapidity."

Another factor is also of importance in outdoor life—that of *solar radiation*, which, as has been stated, does not pass through glass windows. Even though only a small part of the body is exposed to the sun, it may be enough to provide the benefits of ultraviolet and infrared rays, and of other rays whose effects on the body are not yet well understood but are thought to be beneficial.

There is a fourth reason for cultivating the habit of being outdoors in all weathers; it trains the mechanism for *temperature regulation*. Those who have become accustomed to the various extremes of weather are less likely to be injured by them than are the tender "hot house plants" who spare themselves all unnecessary contact with the elements. This is particularly noticeable in those who have become "toughened" to cold by frequent exposure to it; they are often extremely hardy individuals, with good general health and particularly with a high resistance to chilling and the adverse effects of it. They appear to live at a higher level of energy production, and to profit by it in many ways.

Of equal importance, perhaps, is the fact that those who are habituated to outdoor conditions are not made uncomfortable by exposure to cold; they are able to enjoy themselves the year around, whereas those who have not developed such hardiness are miserable in any but their accustomed cozy indoor warmth.

Certainly it is an advantage to be able to adapt well to the various sorts of weather that inevitably occur in the climate where one lives. A well person should be able to do so, by judicious exposure. The adjective judicious means in this connection, a degree of exposure that at no time involves the risk of either chilling or overheating.

Walt Whitman said, "Now I see the secret of the making of the best persons; it is to grow in the open air." Perhaps he had in mind another benefit of outdoor life, the feeling of being part of Nature and the whole creation—a feeling that does much to put one beyond the harassment of man-made problems.

B. INDOORS

Although man early discovered the effect of outdoor atmospheric conditions upon health, he appears to have been inordinately slow in becoming interested in the possible effects of indoor air. From the time that man first built himself a hut and took his fire inside with him, indoor air must have been objectionable, and the more airtight he learned to make his structures, the worse it became.

The climax seems to have arrived when glass was first used for windowpanes, in the 15th century. Before then, the windows, scarcely more than slits in the walls, had been left open part of the time and closed by boards at night and in bad weather. At first, glass windows were a great luxury; it is reported that in the English royal palace in 1661 only the principle chambers contained them. Since glass windows served to admit light whether open or closed, the tendency was to keep them closed to conserve heat. However, with tallow candles and fish oil lamps for lighting and fireplaces for heating, the disposal of smoke, soot and fumes became a difficulty, which was solved to some extent by the introduction of flues. Flues had not been widely used before then. In the 15th century a law was passed in England making them compulsory.

By the 18th century, the problem of "bad air" was recognized as serious, and scientific attempts were made to solve it.

Early Theories.

After the discovery of oxygen, by Priestley in 1774, it was found that the percentage of oxygen was lower indoors than outdoors, and it was assumed that when indoor air became bad it was because the supply of oxygen had been depleted by the breathing of the occupants of the room. But in 1777 Lavoisier, the discoverer of combustion, proved experimentally that in any ordinary rooms the percentage of oxygen never falls so low as not to supply all that is needed for breathing.

It was next thought that if bad air was not due to shortage of oxygen it must be due to excess of carbon dioxide. In high concentration carbon dioxide was known to be poisonous, and it was suspected that even a slight increase of it in the air, after the air had been breathed and rebreathed, might be poisonous enough to account for the discomfort of "close" rooms.

Claude Bernard in 1857 and Pettenkofer in 1862 proved to the contrary; they showed that even in the worst ventilated rooms, in any ordinary conditions of occupancy, the percentage of carbon dioxide does not rise to a degree that is at all harmful.

These discoveries showed what did *not* make indoor air bad, but not what *did* make it bad. Bad air had still to be accounted for; it was a disagreeable reality without a known cause.

In the 1880's attention centered upon the observation that when air is bad it has an unpleasant odor, and it was suggested that volatile substances emanating from human bodies might be the poisons that gave bad air its harmful effects. This theory was

thoroughly investigated. For a generation it had a number of proponents, but no one ever succeeded in proving that human beings give off any organic poisons into the air.

Nevertheless, as long as the theory of emanations prevailed, it greatly stimulated scientific and popular interest in ventilation, the aim being to bring large quantities of outdoor air indoors, in order to dilute and remove the "morbific matter" believed to be present in stale air. As relics of that generation, we still have a few "fresh air fiends" who believe they should live in a gale.

Foundation of Modern Theories.

Among the early experiments that gave conclusive evidence regarding indoor air were those performed by Flügge and his assistants in 1905, as follows:

(*a*) A subject was confined in a room in which the air was allowed to get very "bad." The air, as is usual when it is bad, showed a high percentage of carbon dioxide. The subject was kept in such air until he felt the usual symptoms. Fresh air from outside was then piped directly to his nostrils, so that while surrounded by bad air he was breathing fresh air. No relief came to him. Then air of exactly the same temperature and humidity as that in the room, but with the correct amount of carbon dioxide and oxygen, was allowed to enter into the room. Still he felt no more comfortable. Then an *electric fan* was started in the "bad air." Immediately he felt better.

(*b*) In the next experiment, air with a low oxygen and high carbon dioxide content, but of *low temperature* and *low humidity*, was blown into the room containing bad air. The hitherto uncomfortable man immediately experienced great relief, although the ratio of carbon dioxide and oxygen had not been improved. The conclusion was that air that was cool and moving and not too moist was what he needed, rather than air containing an increased amount of oxygen and a decreased amount of carbon dioxide, and that he needed it *around his body.*

(*c*) In order to confirm these conclusions, the man was taken outside the room containing bad air into fresh air, and the bad air from the room was piped to him for him to breathe. As long as his *body* was in good air he was able to breathe the air containing less oxygen and more carbon dioxide without feeling any ill effects.

These and similar experiments were performed by Leonard Hill and his colleagues in England, and by the New York State Commission on Ventilation in 1914–15.

Good Indoor Air.

From all experimental work it has been concluded that it is not the chemical qualities of the atmosphere, but its *physical condition* in respect to *temperature, moisture*, and *motion* that is of importance. Whether the outdoor atmosphere or the indoor is under consideration, it is the air roundabout the body rather than the air breathed into the lungs that normally makes the difference in feelings, efficiency and health.

What we seek, then, is a good *indoor climate*. That result is to be attained by *air conditioning* in respect to the three physical qualities mentioned, either with or without the use of special apparatus.

Details of good air have been worked out for large public meeting places, working places of all kinds, and private homes—in fact, for all indoor conditions.

Temperature.

In 1920, Dr. C.-E. A. Winslow, a leader in the study of indoor atmosphere, gave, as the first characteristic of good air, a *cool temperature*. All experimental and statistical work since then has confirmed his view; more than ever it is now clear that bad indoor air is air that is too warm.

The accepted standard for room temperature in dwelling houses with natural humidity is approximately 70° F. at 5 feet from the floor, on a thermometer located where it will register correctly—that is, not near a window or radiator and not on an outside wall. This temperature should be comfortable for the normally vigorous person suitably clad and at rest. The *optimum* temperature is within a degree or two of 70° F., women usually preferring it a little above and men a little below.

The temperature standard was reached as a result of subjective tests of the comfort of individuals and objective tests of their fitness and productivity in so far as it could be definitely related to temperature. Statistical reports are available from many sources.

In too warm a room, many people experience sluggishness of mind, inability to concentrate on work, either restlessness or sleepiness, a disinclination to work and a tendency to stop work, and headache or a "stuffy feeling" in the head.

It has been learned through experiments in stores, factories and schools that people not only tend to feel better but to work better if the temperature is within the optimum range. Although power may not be actually diminished, the zeal for work is; and because of mental and physical inertia, less work is likely to be accomplished.

It is also clear that the resistance of the "hothouse plant" whether plant or animal, is lower than of those who live in less enervating conditions. Clearly, those who spend much of their time in overheated rooms do not thrive.

The bad effects of being too warm are due to (*a*) faulty distribution of blood, leaving vital organs less well supplied when much blood must go to the skin to be cooled; (*b*) lowering of the rate of metabolism; and (*c*) actual slight rise of body temperature in spite of lowered metabolism.

Too low a temperature indoors is equally harmful, but for many people is more uncomfortable and therefore less likely to be endured for long. But there is a danger zone in the region of 65° F. This temperature is not cool enough to attract attention to the need for voluntary action, nor to stimulate the body's automatic action to generate heat and restrict loss of heat. As a result, those who remain long in a room just under the optimum temperature may become chilled.

It is thought that optimum temperature is as important a health objective as optimum diet.

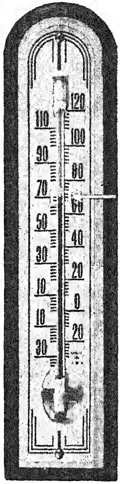


FIG. 137.—Thermometer showing optimum indoor temperature. All thermometers should be marked thus.

Moisture.

The standards of the American Society of Heating and Ventilating Engineers permit a range between 30% and 60% of saturation for indoor temperature. The former figure would perhaps be the most practical as an ideal for homes and the latter for public places. Where many people gather the humidity tends to rise, owing to moisture given off from skin and lungs. In rooms occupied by only a few persons the air does not become moistened thus; on the contrary, in the heating season it may become overdried by artificial heat. Too much moisture in indoor air is uncomfortable; too little has a drying effect upon the skin and mucous membranes, which may harm them.

In winter, outdoor humidity will usually be low, and indoor humidity will correspond. In overheated houses, the humidity may be lower than in any habitable region. It will not reach 30% except by artificial means. Yet research seems to show that most people

feel as well, work as well, and keep as well with humidity at 20% as at 30%.

Without attempts to increase the moisture in the air, but with care not to reduce it by overheating, indoor humidity in winter will average not far below 20%, and this is considered satisfactory. If furnaces and radiators are supplied with waterpans, and these are kept filled, the margin of safety is increased.

It should be noted that natural humidity is satisfactory only if the temperature is *kept* in the neighborhood of 70° F.; if allowed to rise high even for a few minutes the air will be dried and will remain so for some time—steadily so, if the rise occurs daily.

Motion.

Air from outdoors enters a building in a given volume and at a given velocity, the latter measured in feet per second, or per minute. The velocity of air as it enters a room depends upon, first, its velocity outdoors; second, upon the relative temperature indoors and out; and third, upon the size of the opening through which it is admitted. When outdoor air is very cold, the wind may "whistle" even through a small opening, although outdoor velocity is low. Indoors, a natural circulation of air takes place, because hot air rises and cold air falls.

The significance of these facts combined is that much air may enter a house in winter even through small openings, and may set up pronounced currents. In fact, so much air enters through natural spaces around windows and doors that it is scarcely necessary to increase the amount except to remove objectionable odors and smoke or excess heat. This is true even when weather stripping, storm windows and storm doors are used, and no fireplaces are present.

Recent findings indicate that natural air motion, like natural humidity, is satisfactory indoors provided that heating is correct. The rate should not be more than 15–20 feet per minute. Rough estimates may be made by the use of a candle flame; it will move, but barely move, when air motion is correct.

There would be no objection to a more rapid rate of air motion if it did not create drafts. A draft is a clearly perceptible current of cooler air. Drafts cause dangerous local lowering of body temperature, with perhaps general chilling. The feet and ankles are especially sensitive to drafts. Since cold air falls, the lower parts of a room will be cooler than the upper. Therefore windows, if opened, should be opened from the top; or, if from the bottom, deflectors

should be used. The temperature at 18 inches from the floor should be at least 65° F. All recent studies of indoor atmospheric conditions have placed less emphasis upon increased air motion than upon preventing drafts.

Natural Ventilation.

The inflow of outdoor air through natural openings is called natural ventilation (*ventus*, wind). As stated, it usually supplies sufficient exchange of air and sufficient air motion under normal housing conditions. However, there are conditions in which it may be inadequate.

Obviously, not enough natural ventilation will occur in a room if the amount of window and door space (hence inward seepage of air) is too small in proportion to (*a*) floor space and cubic contents of the room; (*b*) number of occupants; (*c*) amount of contamination of the air by odors, smoke and fumes; and (*d*) amount of heat. The code of the Federal Housing Administration calls for rooms of given dimensions with openings of sufficient size to provide for natural ventilation under usual conditions of occupancy, and mortgages are not issued on houses not complying with the code.

Additional Ventilation.

When it is necessary to exchange indoor air for outdoor at a more rapid rate than through natural openings, extra ventilation is accomplished either by (*a*) open windows; or (*b*) ventilating fans inserted in windows or walls; or (*c*) mechanical systems of ventilation consisting of ducts through which fresh air is forced into a room (plenum system; *plenum*, full) or indoor air is drawn out (exhaust system or vacuum system; *vacuum*, empty).

Fans are useful in homes (e.g., in kitchens, to remove heat and odors), and they meet the needs in certain other conditions. In many industries, and also in public gathering places, mechanical systems of ventilation are virtually essential. They are planned to function when windows are closed, and do not operate otherwise.

Air Conditioning.

Air conditioning includes methods for air exchange (i.e., ventilation), but it includes much more, for ventilation by itself does not necessarily bring the air to the proper conditions of temperature, moisture and motion.

In homes lacking apparatus for air conditioning excellent results for the average well adult may be obtained during the heating season by observing one rule—never allow the thermometer

to go much above 70° F. As has been mentioned, in a room kept at this temperature both humidity and air motion may be practically ignored.

Apparatus for air conditioning provides for the following: (1) Heating; (2) Cooling; (3) Humidification; (4) Dehumidification (especially important in summer); (5) Purification, i.e., removal of foreign matter (either filtering air or washing it by passing it through water or spraying it with water); (6) Ventilation, i.e., exchange of indoor air for outdoor; (7) Deodorizing (usually accomplished by purification and ventilation, but by other means if necessary); (8) Circulation (of the "manufactured" air, at the correct rate of motion).

Mechanical systems are especially valuable in buildings where crowds gather and temperature and humidity are high. Under such conditions it is extremely difficult to keep the atmosphere satisfactory by the use of heating systems and windows only, or even with additional ventilating devices. Complete systems are now in use in many theaters, stores, restaurants, large offices and the like.

Difficulties have arisen in determining the degree to which cooling should take place in summer. The optimum temperature for an artificially cooled room on a hot day is not 70° F. but somewhere between that temperature and the outside temperature. A sliding scale is used, indoor temperature rising with outdoor temperature, but at a slower rate. Many authorities believe the scale needs revision, to make less contrast between outdoor and indoor temperature. In the meantime, individuals entering an overcooled place on a hot day should, if lightly clad, leave it at once.

Air conditioning apparatus in homes is practical if the structure of the house is adapted to humidity higher than natural. Perhaps its major advantage is that of cooling and drying the air in summer.

Chapter 35

LEISURE AND RECREATION

Until this century, neither leisure nor recreation were in good repute among the mass of the population. In fact, it was thought that leisure was not for average mortals. Buckle, in his "History of Civilization in England" stated that there could be no leisure without wealth. Without wealth and leisure, it was futile to think of amusements.

In former times, to wrest a living from the soil or the sea or from manufacture or trade had to be nearly a twenty-four hour job, with twelve hours of work and the other twelve for eating and sleeping to provide energy for more work. The work in the home was similarly time consuming. As Longfellow said, "Life is real, life is earnest." The person who took time off from work was considered, and probably was, an irresponsible slacker. A self-respecting person scarcely interrupted his work for any reason except sickness.

Play was looked upon as diversion suitable for children, or at least excusable in them because of their natural exuberance of youthful spirits, but unbecoming in the sober adult. And since it represented a leisure to which an adult was not entitled, recreation was considered at least a waste of time and in most cases a downright sinful one.

The Era of Play.

The first quarter of the 20th century will undoubtedly be viewed by historians of the future as notable for the complete change that came over the spirit of man in his attitude toward play, and the beginning of an era in which recreation took a respectable part in the life of the masses of the population. In no other era except possibly the classical era in Greece, has recreation been more than tolerated; now it is not only tolerated but has become a major objective in the minds of individuals and in the program of organizations working for human health and betterment.

The changes that finally culminated in this century in nationwide habits of recreation, were partly due to changes in *economic conditions*. Earning a living became a simpler matter, because of

the invention of labor-saving machinery of many sorts. This affected, directly or indirectly, the hours of labor of persons in a great many occupations. Also, it added to the wealth of the country, and promoted its wider distribution. Leisure became available, and with it a new interpretation of what constituted waste of time. The words of the Declaration of Independence, stating that the inalienable rights of humans are "life, liberty and the pursuit of happiness" were for the first time construed as including a right to amusement.

During the same period, *scientific studies* were important in bringing about the changed attitude toward play. Physiologists and psychologists recognized that the human organism may be greatly benefited by the change of interests and activities such as recreation affords. The term recreation regained its original meaning—*re-creation.* One of the early results of these studies was the introduction of facilities for recreation in colleges.

The Recreation Movement.

The present organized public health movement in behalf of recreation may be said to have begun with the work of Joseph Lee in Boston in 1895. It was directed toward the welfare of children, but it led more or less directly into work for adult recreation. Lee found that in some quarters of the city the children had no place except the streets in which to play. Lacking suitable opportunities to follow their native impulses constructively and safely, these children were prone to get into mischief and danger, he found. Therefore he set himself the task of doing something about it. The first results of his efforts were three sandpiles, but it took several years to interest the public in providing real playgrounds with apparatus. Lee's work attracted attention, and by 1903 there had appeared in the United States as many as eighteen such municipal playgrounds; today there are thousands.

It was but a step to the providing of municipal facilities for games for adults. The "gentleman's" games of tennis and golf soon became games for all, played on municipal courts and courses in all large cities.

The Playground and Recreation Association of America was organized in 1906 with the endorsement of President Theodore Roosevelt, the advocate of the "strenuous life." It was reported that in ten years, not long after its founding, it had interested municipalities in spending \$50,000,000 for building and maintaining playgrounds and recreation centers, for purchase of equipment, and for paid leadership.

In the meantime, many industrial concerns had learned that "play pays." At first, when shorter hours were demanded, some employers were averse to granting them on the ground that workers would not know what to do with their spare time, and would get into trouble—and not only that, they would lose their industrious habits of work. But after shorter hours were granted, it soon became clear that working power was increased rather than diminished. Many workers spent their spare time in outdoor play, and those who did so often turned out to be the best workers. Many industrial employers even built club houses and recreation grounds on their own premises for the free use of employees. Their recreation programs were patterned somewhat after those that had already been established for young people in schools and colleges. These private facilities became less necessary as public facilities increased.

Commercial Developments.

A third development came as a corollary of the other two; if people wanted to play, and doctors thought they should do so, commercial forces were ready and willing to capitalize recreation and obtain their fair share of the credit for making facilities available and of profit from the trade in the new amusement business. Although somewhat commercially propagated, such amusements as dancing, bridge, the movies, the radio, automobiling and camping, bowling, skiing, gardening, and professional sports for the interest of spectators could not have attained their enormous popularity unless they had met a corresponding demand in the heart of the public—the demand for fun.

Present Problems Regarding Recreation.

It might be supposed that the recreation problem had been solved by the arousing of popular interest in recreation and the providing of opportunities to obtain it in numerous forms according to taste. Such is not the case, however.

From the health point of view, two difficulties remain. First, some people still do not appreciate the *need* for recreation; and second, many do not make *appropriate choices* of recreation, and instead of renewing their energies they deplete them.

"All Work and No Play."

At the present time there are unfortunately many people, chiefly business executives and professional people, who find that recreation does not fit into the picture of their lives. This type of hard working individual is the center of a considerable amount of medical interest

today. Every physician knows of many such workers who have brought all their efforts to naught by the very effort itself. To mention only one possible eventuality, the form of heart disease that involves the coronary arteries seems to be definitely related to this type of intense and unremitting application to hard work. It does, to be sure, occur in others than in "high pressure" workers, but its incidence among the latter is striking. The disease is much more common in men; in fact it seldom occurs in women except those who have similar working habits.

Those who know the conclusion of the phrase "all work and no play" often do not realize that being a dull boy is not the only penalty for confining themselves too closely to work. Yet the mere dullness itself is worth consideration; the quality of the work is likely to suffer when it is the worker's only interest in life.

Work and Play Combined.

There are those who find so much pleasure in their work that they feel no need for leisure and recreation. Some few—like Edison—can work effectively practically all their waking hours. But most cannot; staleness comes on, and the work suffers.

Even those who enjoy their work the most are likely to find that to swing away from it periodically, as a pendulum, usually means swinging back to it with renewed interest and vigor, and with a better perspective upon it.

A wise man is seldom a "fool for work." Albert A. Michelson, the Nobel Prize winner in Physics, alternated his activities in measuring the speed of light with measuring himself against his friends as a tennis player and a billiard player. He was also an artist and a violinist of considerable attainment.

Distribution of Time.

With many individuals the difficulty is not to generate an interest in recreation and to find time for it, but the reverse—to become interested in work and to stick to it closely enough. A large proportion of our population is not held by any force outside itself to long hours of labor; if a person works from dawn to dark today it is usually because he wants to, either from a liking for work or a sense of duty or necessity. Actually, the majority of workers in industry and business are working under laws establishing from 40–44 hours as the working week, or less than one-fourth of the total number of hours per week. In colleges, far less time is scheduled for classroom and laboratories. It appears that for many persons the problem of suitable disposal of time not scheduled for working

is of paramount importance. Such time may easily be idled away so as to give no particular pleasure or benefit. Or it may be filled with the sort of "recreation" that belies the meaning of the term, in that it does not contribute to well-being.

At the end of a day or a week or a year, if one feels dissatisfied with his accomplishment it is probably more often because of scattered time and energies than from lack of ability or of good intentions.

Bernard Baruch said "The man who can master his time can master nearly everything." When a person has succeeded in mastering his time, how has he accomplished it? It would appear that he has first analyzed his aims and the steps that must be taken to reach them, and has similarly analyzed the values, to him, of the various activities in which he might engage; and then has measured the relative amounts of time to be allotted to each. One usually finds that activities may be classified rather definitely as of major or of minor value in relation to the scheme of life as one has planned it, and that it is possible to assign a major or minor proportion of time to them on that basis.

In any such thoughtful apportionment of time, recreation would certainly be allotted its fair share, with the likelihood that it would be constructive if the apportionment of energy were made with equal care.

Choice of Recreation.

The most vital choices an individual makes in determining his survival and his achievement may be his choices of recreation. It is as important to choose recreation to conserve and promote physical and mental vigor as to choose foods for that purpose. Large numbers of hard workers keep fit because they choose precisely the sort of recreation that suits them, both for pleasure and renewal.

From among the many activities that are entertaining and diverting, it should be possible to choose those that will not only renew one's zest for work but one's ability to work. To make such a choice the work itself must be considered first—the sort of energies it uses and its physiological and psychological effects. Qualitatively, recreation should balance work, bringing different energies predominantly into action. Many occupations entail somewhat trying conditions, such as sitting still indoors for hours at a time, using the eyes continuously for close work and the mind for solving problems. Such conditions may be harmless throughout a lifetime

to a person in good health provided that during the leisure time similar conditions are not continued.

Although the need for change from mental to physical activity and from indoor to outdoor is fairly obvious, it is not always realized how vital a matter it may be in a given case. Similarly, for the person who works alone at monotonous or intense work the greatest need may be for sociability in recreation. In general, the principal of contrast should prevail.

Quantitatively, recreation should use an amount of energy that does not bring the sum total of fatigue to too high a level. Many persons become gradually less and less vigorous in health, and some even break down, as a result of their play rather than their work. For example, a little outdoor exercise goes a long way with some persons, and what they need is recreation of a quieter sort, giving them pleasure without wearing them out. To count the calories *used* in the daily life is as important as to count those *received* through the daily diet.

Beyond the actual use of physical energy is the matter of nervous tension and strain which may be associated with comparatively inactive recreation. This is a matter of individual reactions; for no apparent reason some persons are wearied by activities that are restful to others.

Effector and Receptor Recreation.

It is useful to distinguish between the effector type of recreation, which involves actively *doing* something with muscles or mind, and the receptor type, which involves passively *receiving* amusement through the eyes and ears. Most recreation can be classed as predominantly one or the other. Each has its place as a means of relaxation and renewal.

The *effector* types of recreation offer opportunities for satisfaction in the use of powers, and if chosen with due respect for the amount of energy available, are particularly valuable as a constructive force in personality as well as in health.

In the past few years all members of the freshman class in one of the colleges have been asked to name their favorite recreations. A majority (79%) mentioned only the effector types, and 59% gave only the various outdoor sports. However, when presented a list of many forms of recreation and asked to check it, the majority of students were reminded that sports and games were not the only recreation they enjoyed. Outdoor sports still held the lead, with indoor games second; but many students also expressed an interest

in the various arts (sketching, painting, playing on musical instruments, sculpture) and crafts (sewing, knitting, metal work, etc.), and in hobbies (dogs, stamps, gardening, photography, etc.) The total of those who favored these types of effector recreation was, however, only 8%—too small a proportion in view of the possibilities of enjoyment they afford, both in youth and as age advances.

The *receptor* types of recreation offer change and enrichment of the content of thought while keeping the expenditure of energy at a low level. Even among the young and vigorous they are popular, and are the main source of amusement among many of the feeble and elderly. The movies and the radio together ranked first with 17% of the college students mentioned, and ranked high on the list for 41%. If reading for pleasure were included, these three receptor types of recreation ranked nearly equal to outdoor sports. Undoubtedly their attraction is not entirely their pleasure value, but partly the cultural enlightenment they afford.

Solitary and Social Recreation.

For many people play is hardly play unless it is with somebody else. Of the college students mentioned, 84% preferred companionship in any form of recreation, even in listening to the radio. Of course it is essential that individuals learn to live—to work and to play—in mutually agreeable relationships with others. In fact this is one of the tests of mental health. On the other hand, it is just as essential that an individual enjoy his own society and have resources of his own for recreation by himself.

A tendency either to be too dependant upon others or to withdraw from one's kind as a regular practice suggests the need for revision of one's assessment of values.

Prescribed Recreation.

Modern preclinical medicine analyzes an individual's habits of play as carefully as his other habits, and often finds occasion to prescribe a particular sort of recreation as a means of health maintenance or as a form of treatment.

Vacational Guidance.

It is reported that 35,000,000 people in this country go away from their homes for vacations every year, for which they spend a total of $5,000,000,000. For this huge sum they should receive commensurate dividends in health as well as in pleasure, and most of them could if they gave due thought to the matter or received suitable advice.

Chapter 36

POSTURE

Many of the forces of Nature would be injurious to man if he did not adapt to them. In no respect is this more true than of the force of gravity, which tends to pull man toward the earth. Humans have an automatic apparatus to keep them upright, but any upright posture must be looked upon as a triumphant adaptation to the laws of gravity.

However, merely remaining upright is not the whole story. The body is, from one point of view a mechanism, operating according to the principles of physics. It consists of weights variously distributed in respect to levers, with muscles that constitute the power, and joints that, as they are moved, permit the redistribution of weight.

Regarding any mechanism, correct operation means the most effective use of energy with the least damage to the mechanism itself. Good posture, then, is good mechanical use of the body, involving the minimum of muscle power, and producing the minimum of harm to the working parts (joints and muscles) or indirectly to any other parts.

Skeletal Alignment.

The skeleton cannot be lined up so that it will balance itself completely; as soon as muscular control is lost, as in unconsciousness, the body topples over. Nevertheless, it can be lined up so that gravity exerts a minimum of pull toward the earth, and the minimum of muscle power is needed to keep it upright. In the most favorable alignment, the center of gravity of each segment of the body is directly above that below it. A plumb line dropped from the ear will pass through the center of the neck, shoulders, hips and knees, and the plumb-bob will be at the center of the ankle.

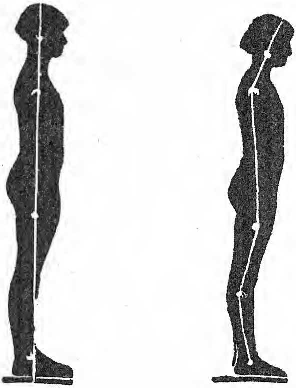
Muscular Control.

Nearly 300 muscles are used in standing—100 in the legs and feet, 155 in the trunk and 20 in the neck. They are all voluntary muscles, controlled by the postural reflexes and by voluntary efforts. The reflexes depend upon afferent stimuli from the sense organs in muscles, and sensory impressions from the eyes and from the sensory

nerves in the balancing mechanism in the inner ear. The cerebellum also has an important part in balancing.

Upon the receipt of stimuli from these various sources, reflex motor impulses go out to the 300 muscles, causing them to contract or relax appropriately for maintaining the body in the erect posture. Voluntary action is not essential merely to keep erect.

The muscles which act reflexly in maintaining erect posture are of two sorts; with reference to the force of gravity they may be



a b

FIG. 138.—The axis of the body in (a) good posture, and (b) poor posture. (From Bilhuber and Post's "Outlines of Health Education for Women." Courtesy of A. S. Barnes & Co., Publishers.)

called *protagonists* (favoring gravity) and *antagonists* (opposing gravity).

The antigravity muscles are chiefly the extensor muscles on the back of the neck and trunk, the muscles in the ventral abdominal wall, those on the front of the thigh whose tendons pass over the knee, and those on the back of the leg whose tendons pass behind the ankle. Antagonists and protagonists are arranged in opposing sets, as shown in Fig. 139, one set contracting while the other set relaxes. At times, both sets contract together to maintain rigidity of the spine or of a limb.

In ordinary circumstances, a posturing muscle does not contract as a whole, but a few muscle fiber bundles act in succession or in

relays, with successive recovery. Therefore the maintenance of the erect posture requires little energy. A posturing muscle is said to show a metabolic rate only 25% higher than a paralyzed one. This means that fatigue does not occur readily as a result of standing. In fact when a person in good posture becomes weak and tired, it is usually because the distribution of blood is unfavorable as a result of immobility, the brain perhaps not receiving as much as it should.

FIG. 139.—Diagram illustrating the muscles (drawn in thick black lines) which pass before and behind the joints and by their balanced activity keep the joints firm and the body erect. (From Martin, "Human Body," Courtesy of Henry Holt & Co., Publishers.)

Eccentric Loading.

If any part of the body is held off-center, another part must be off-center to counterbalance it. The body can be kept from falling when its various parts are off-center, but only at the expense of extra muscular effort. Engineers use the term eccentric loading; they know that in any structure they must either guard against it or provide extra support for it.

It is eccentric loading that is the important element in most types of poor posture and poor carriage in walking. The difficulty arises most commonly as a result of the fore-and-aft mobility of the spine.

Spinal Curves.

At birth the spine is straight, but after walking begins four slight fore-and-aft (antero-posterior) curves appear. They are an advantage in giving resilience in motion; walking would be uncomfortable if the spine did not "give" a little with every up-and-down motion.

The spinal curves are: the *cervical*, forward at the neck; *dorsal*, backward in the upper spine, with the convexity greatest at the shoulder level; *lumbar*, forward at the waist; and *sacral*, backward at the hips.

Each spinal curve is very slight, and they alternate in their direction, so that the spine as a whole is perpendicular. Bending can take place at each of the many spinal joints, so as to increase or decrease these curves as the body moves. But the joints are so constructed and the weight of the body so distributed that forward motion (flexion) is of wider range than backward (extension). There is

need, all through life, to guard against overflexion of the spine, i.e., stooping posture.

As a result of a slight increase in one of the spinal curves, another curve may increase to counterbalance the weight that is thrown off-center by the first increased curve. Whenever spinal curves are changed from normal, even though a second curve partly compensates for the first, satisfactory balance is seldom possible without further compensatory bending at the hips, knees, and ankles. Once any normal spinal curve is increased, a vast number of disadvantageous changes in relationships between bones may occur, and the whole problem of balance be made complicated.

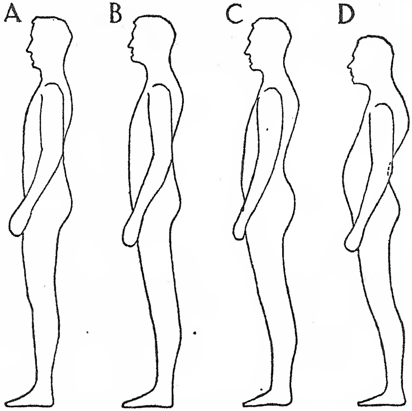


Fig. 140.—Tracings made during examination of 700 Harvard freshmen. A, 7.5 %: B, 12.5 %: C, 55 %: D, 25 %. Represent respectively: good, fairly good, bad, and very bad mechanical use of the body. (Used by permission of the Department of Hygiene, Harvard University.)

Testing Posture Visually.

Whether or not an examination of posture by an expert (physician or physical director) is available, it is desirable to study it personally, by the use of mirrors so arranged that one may obtain a side view and a back view without twisting.

The first point to note is the *axis of the body*, as seen from the side. With assistance, the plumb line test may be done; without it,

one may estimate by the eye whether there is a forward or a backward list at any joint from ankles to neck. A common type of distortion is shown in Fig. 138*b*.

Second, the *spinal curves* should be noted. The most common defect is an increase in all the spinal curves, often more conspicuous at first glance in the dorsal curve.

The dorsal curve is increased in two typical ways. The first is a short deep curve called "round shoulders," or kyphosis, usually with an equally deep compensatory curve at the waist, called "hollow back" or "sway back" or lordosis. This type of exaggerated dorsal curve is shown in Fig. 140*d*. The second is a long curve from neck to waist, called "long round back" with a compensatory short sharp forward curve just below the waist, as shown in Fig. 139.

With either of the two types of increased dorsal curve the neck curve is usually increased also, causing the head to be carried forward, and the hip curve is increased, causing the buttocks to be carried higher and farther backward than normal. The chest is certain to be low, and almost invariably the abdomen is prominent. Usually the shoulder-arm joints are forward, and the shoulder blades project ("angel wings").

Testing Posture Mechanically.

The following tests will give a clue to the correctness of one's customary posture. (Incidentally, they may also be used as exercises for improvement of posture.)

1. Stand against a wall, with the head, shoulders, buttocks, calves, and heels touching it. Put the hand between the wall and the neck, and then between the wall and the "small of the back." In neither location should there be a space of more than 1–1½ inches, according to stature. In the slim and flexible, the waist and the spine below the waist should nearly touch the wall when the heels are flat on the floor. In all persons it should be possible when the heels are moved a few inches away from the wall.

2. Having flattened the body against the wall, walk away from it in that position. If this feels unfamiliar and unnatural, one may conclude that one's usual carriage is faulty.

3. Walk toward the wall until the toes touch it. The chest should also touch it, but not the abdomen nor the nose. The nose should clear by at least two inches, even in the slim.

4. Lie on the floor with the knees up. Flatten the back so that there is no space or very little space between the waist and the floor. Then slowly lower the knees until they touch the floor, trying meanwhile to keep the waist, and the spine below the waist, close to the

floor at all stages. Then try to raise the knees again, still keeping the back flat on the floor.

5. Measure the space it takes to pass sidewise through a partly open door. Then try to re-align the body so that it will pass through a narrower opening. This should be done without lowering the chest. When alignment is good the projections of the body are nearer the central axis and the silhouette slimmer.

6. Place a book on top of the head, balancing it while holding the chin in the normal position, and walk about. If the position necessary to keep the book in place seems awkward, one's usual carriage is not well balanced.

Ten Rules for Posture.

To keep posture good, or to correct any departures from normal, the following points are among the most important.

1. *STAND TALL.*—This is a universal rule for correct posture, whatever the stature or the postural defect. It applies to all persons in all conditions at all times.

2. Raise the breast bone. As it rises, the spine in that region flattens. It should be kept moderately high all the time, allowing for a little additional rise in breathing.

3. Balance the body on both feet, in such a way that it will not list forward or backward at ankles, knees or hips.

4. Push the upper back part of the head as far upward and backward as possible, without forcing the chin inward or upward or downward, but practically ignoring it.

5. Press the shoulders downward and slightly backward, so as to bring the shoulder blades flat against the back.

6. Allow the arms to hang freely, not pressing the elbows backward.

7. Widen the chest moderately from side to side, allowing for a little additional widening in breathing. Gauge the widening by the intercostal angle, the angle formed by the ribs just above the waist. It should be nearly a right angle.

8. Flatten the abdomen, exerting an inward and upward pull on the muscles of the abdominal wall. Do this not by drawing in the breath, but by the use of the muscles. It should be possible, especially in the young and slim, to make the abdomen nearly flat.

9. Tilt the hips to their normal angle, as shown in Fig. 141. Usually the hip bones must be brought to a more horizontal position, a manoeuvre that is not always easily accomplished at the first trials.

10. While holding the posture just described, see whether the body feels rigid. If it does, try to hold it in the same position while relaxing the muscles everywhere just enough to take away the rigidity. To obtain the unstrained "feel" of good posture it is helpful to think of one's self as suspended from above by the upper back part of the head.

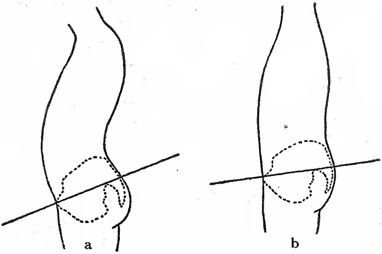


FIG. 141.—Diagram to show the angle of the pelvic bones and angle at the groin in (a) poor posture, and (b) good posture.

Causes of Poor Posture.

Muscular weakness is the outstanding cause of the onset of poor posture. It usually begins at a time when nutrition is poor or fatigue is great, or the muscles are weakened by illness. The extensors of the neck and back being weak, the upper part of the body begins to droop forward in passive yielding to the force of gravity. And once such yielding has begun, it tends to be progressive. Then the compensatory curves at the waist appear.

In the absence of muscle weakness a visual defect may start the habit of bending forward in order to see better. Poor light on the work may have the same effect. So also may a faulty height relationship between desk and chair.

At any time in life the majority of those found to have poor posture have no lack of muscle power at the time, but only a habit of not using it to advantage, the habit having been acquired at a previous time in life when muscle weakness actually was present. The minority do lack strength to maintain good posture.

For the former, the majority, training of the extensor muscles in holding the body in correct alignment is all that is necessary—a simple task when strength is adequate. For the latter, those who are really weak muscularly, more muscle strength must be obtained through whatever means are called for—usually by better nutrition, more rest, and a reasonable amount of general and special exercise.

Efficiency of Good Posture.

Good posture is called good because it is mechanically correct. First, it is efficient and economical of energy. It is easier to balance the body in correct alignment than in any incorrect alignment.

After one has learned to stand and walk and sit in good posture, the technique becomes easier and easier with practice. Eventually, no technique except the correct one feels at all comfortable or natural. A West Point graduate, even as he grows older, seldom slumps, or even feels like slumping.

Second, correct posture favors skill in other mechanical acts. Those who know how to stand correctly, and do so habitually, have an advantage at the start, and through all the stages, in mastering many other techniques. A good stance is the foundation of many motor acts.

Posture and the Joints.

Good posture favors the health of the working parts, and conversely poor posture is harmful to them, especially to the joints. Obviously, if a joint is constructed to move in given directions within a limited range it will be injured if forced to move in other directions or outside its normal range of motion. Continued wrong relationships of bones to each other amounts to chronic sprain. When joints are injured by poor posture the ligaments that normally hold them in place may be stretched or relaxed, causing a "loose" joint; but if inflammation occurs as a result of the extra motion and friction, joints are likely to enlarge and stiffen.

In the spine there are cartilaginous disks between the vertebrae which receive equal pressure throughout their circumference when the body is held erect, but which are unequally pressed upon when the body is habitually carried out of alignment. Irritation of any spinal joint may occur from postural distortion. In the lower back especially, this is likely to occur, in the large joint between the lowest spinal vertebra and the sacrum (the five fused vertebrae between the hip bones), and the joints between the sacrum and the hip bones on each side. These joints are shown in Fig. 142. Some authorities believe that most lower backaches are postural. The pains called lumbago and sciatica are often of this type.

The longitudinal support of the body from neck to feet is a functional unit. No joint in the series can be out of alignment without endangering all the others. Therefore it often happens that pain in one area has its origin elsewhere. It is thought that much of the rheumatism in the knees, for example, is due to eccentric loading above, with distortion of spinal joints that throws the knees out of alignment. Rheumatism is a widespread malady, and one form of the disease is often found in those whose posture has long been faulty. The correction of posture is one of the important methods of

treating that type of rheumatism, whether the patient is upright, sitting in a wheel chair or confined to the bed. Although this type of rheumatism does not appear in youth, the foundation for it often appears to be established then.

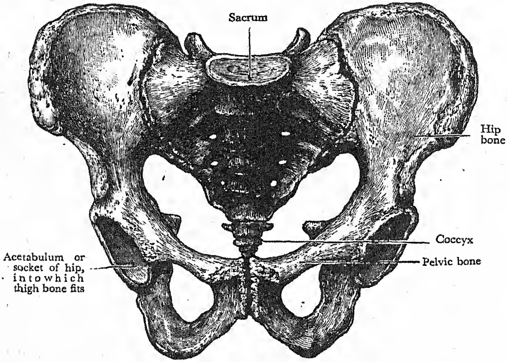


FIG. 142.—The hip bones and the sacrum. (Morris' "Human Anatomy.")

Posture and Organ Activity.

At its best, the upright position is none too favorable for organ activity. The organs instead of being virtually on the same horizontal level, as in quadrupeds, are on several different levels, some above and some below the level of the heart. Therefore circulation to or from organs presents some difficulties (e.g., circulation must be against gravity in carrying blood to the brain, and from the abdominal and pelvic organs).

Furthermore, because the organs within the trunk are in a vertical relationship to each other and to gravity, those above may, in unfavorable circumstances, press downward upon those below.

For these two reasons, any upright position is theoretically less satisfactory physiologically than a horizontal position; and in times of stress (e.g., during shock, when all vital functions are depressed; during illness; and during great fatigue) the horizontal posture must be resumed.

Nevertheless, in everyday life, many potential difficulties associated with the upright position may be avoided and the body's

functions be well performed, if the difficulties are understood and avoided by attention to correct carriage.

The Organs of the Chest.

When the chest flattens and its capacity is decreased, both the lungs and the heart may be prevented from acting as freely as they should. The heart may indeed sag to a lower position than usual. "Dropped heart" was a frequent diagnosis in soldiers in the World War, accounting for many annoying symptoms of poor heart action, such as fainting, rapid pulse, breathlessness, chest pain, and other effects of poor circulation. Those who suffered from the ailment were often more incapacitated than many who had organic heart disease. The diagnosis is less often made at present; nevertheless, it is recognized that much circulatory trouble and functional heart trouble are associated with postural difficulties. One authority states he has found that 85% of angina patients have faulty filling of the heart due to the mechanical difficulties arising from exaggerated spinal curves and distended abdomen.

As for the lungs, it is clear that lungs that are not habitually well expanded will be likely to have a low vital capacity and poor tissue health. It has been suggested that a cramped chest may be a contributory cause of tuberculosis, through lowering of lung resistance. Certainly it is true that many of those who develop tuberculosis do have poor posture and poorly developed chests, although this is by no means invariably the case.

Limited breathing, as has been mentioned elsewhere, has a tendency to result in imperfect oxygenation of the blood, and also to interfere with the return circulation of blood from the lower parts of the body. In this way faulty lung action as well as faulty heart action may be implicated in circulatory disorders arising from poor posture.

The Abdominal Organs.

First, when the chest is cramped and breathing is not full and free the abdominal organs may be harmed, for the motions of the lungs normally exert a beneficial massage effect upon the organs below them, increasing circulation through them.

Second, the abdominal organs may be hampered in their function when they sag downward and forward owing to relaxation of the abdominal muscles. The mesentery, the fibrous structure that attaches the intestines to the posterior wall of the abdomen and carries blood vessels and nerves, may be stretched, sometimes causing circulatory difficulties in the intestines and faulty nerve impulses

to them. The lower position of the abdominal organs may even cause congestion in the pelvic organs.

Any attempts to improve the posture should take into consideration not only these effects of weak abdominal muscles but also the fact that the abdominal muscles are among the important factors in posture. When the abdominal muscles are weak and the abdominal organs are in a more forward position than normal, it is difficult to keep the lower back flat and the pelvic bones inclined at the correct angle. Training of the abdominal muscles is therefore a prime essential in all those in whom these muscles are weak. To keep them strong may mean solving a good many health problems.

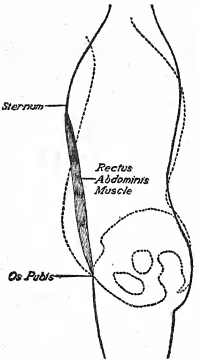


Fig. 143.—Diagram of good posture showing well-developed rectus abdominis muscle in tonic contraction: dotted line showing poor posture with relaxed and flabby abdominal wall. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

Posture and the State of Mind.

In addition to all its other advantages, an erect carriage has a desirable effect on the state of mind. First, it is a source of pride. The body is a possession, and "pride of possession" is one of the important sources of euphoria. Especially is one entitled to pride in a sound body, well managed, since it often is the result of considerable effort and perhaps of self-denial.

Second, as a result of suggestion an upright bearing may help one to be upright in other than physical ways. A person who, after being perplexed and bewildered, straightens up as he makes his decision is manifesting in his body what his mind is doing. There are many who think they have been helped to adjust their psychological difficulties by assuming the posture that comes with problems settled and courage within.

Third, as a result of improved circulation and the improvement of physical function in many ways, the factors causing a disturbed state of mind may be overcome by good posture.

Finally, the state of mind may be improved indirectly as a result of the attitude of others toward a person who carries himself well. Socially and economically, good posture is an asset in both direct and indirect ways.

Sitting Posture.

A correct position is as important in sitting as in standing, especially in the case of those who wish to do good mental work while sitting, and need a good circulation of blood to the brain. Furthermore, if one begins the habit of slumping while sitting it may carry over into the standing and walking posture. In fact, it is thought that most poor posture begins in bad habits of sitting.

To sit correctly one should sit squarely on the chair with the lower spine against its back. Preferably, the chair should be one in which the back and the seat are at right angles, or even a little less, in order to bring the thighs at a right angle with the body. While at rest the whole chair back should be utilized. When it is necessary to bend forward, bending should be done at the hips, decreasing the angle between spine and thighs, or at the joint between the head and the neck, or at both places. An important rule for sitting is "Do not buckle at the waistline," or, stated in positive terms, "Sit tall."

Recumbent Posture.

It is even true that one should "Sleep tall." Whether on the face or side or back, it is preferable to stretch out at full length. Any position is permissible that does not bend the back, contract the chest and push the neck and head forward. It is, of course, essential that the bed should not sag, and that it and the bed clothing be long enough to permit of stretching out in comfort. A pillow, if used at all, should be low.

Walking.

Again, the principle of stretching the spine to its full length is to be followed; the rule for walking is to "Walk tall." Nearly all the rules for standing are equally applicable in walking. Instead of the smooth, poised, easy gait that denotes skilful management of the body, a lurching, jerky, fatiguing gait is inevitable when the body is out of alignment.

Those who can stand well should be able to walk well, but the gait also depends upon the use of the feet and upon practice in the technique of walking.

Lateral Curves.

Normally there are no side-to-side (lateral) curves in the spine. As viewed from the rear, the spine should be perfectly straight. When lateral curves are present the condition is called scoliosis, or "curvature of the spine."

The existence of lateral curves usually cannot be determined by self-inspection in a mirror. Such a curve may be suspected, however, if the two sides of the chest do not appear to be symmetrical, and if sidewise motion to the right or the left or both is limited.

In some cases, scoliosis results from postural habits such as standing habitually with the weight on one foot, or habitually carrying heavy loads (e.g., books) in one arm, or sitting sidewise at a desk with one shoulder raised. As in the case of anteroposterior curves, these are likely to begin at a time in childhood when the musculature is weak.

Occasionally scoliosis is the result of a difference in the length of the two legs. The lower spine curves toward the shorter leg, and the upper spine curves in the opposite direction. Often an extra lift on the heel of the shoe prevents, or cures, this difficulty.

Less often, scoliosis is not postural but structural—that is, it is associated with a bony abnormality of the spine on the trunk.

In most cases of scoliosis, at least a part of the remedy is the same as for increased antero-posterior curves—a stretching of the spine upward. Obviously, the more the spine is lengthened the fewer the curves of any sort. There are, however, various other measures that may be required in scoliosis, especially of the structural type.

Chapter 37

THE FOOT

Prevalence of Defects of the Foot.

a. Former Times.—At the time of the World War, the Surgeon General issued a report on "Defects Found in Drafted Men," in which it was asserted that 12% of all men examined had flat foot and that 2% of the total number of rejections were for this cause. In an examination of infantry it was reported that of 30,000 inspected, 21,335 were wearing too small shoes, and 3,511 were wearing too large shoes. There was a total of 73.9% wearing unsuitable shoes.

Aroused by this report, many examinations were made of workers in industry, college students and numerous other groups. The statistics from all sources were virtually the same. It was found that defects of the feet were second in frequency only to defects of the teeth.

b. Era of Education.—Thereafter much educational work was done to draw attention to the prevalence of weak feet, and the need for strong feet. Many industrial employers adopted the Army standard and made strong feet a requirement for applicants for certain kinds of work. Attempts were made to acquaint the public in general, and as many individuals as possible, with the two chief methods of keeping the feet strong—using the feet correctly and wearing well fitted shoes. Shoes manufacturers were advised regarding lasts over which to make shoes that would fit normal feet, and shoe salesmen were advised regarding fitting shoes to individual customers.

c. Modern Times.—Today conditions are somewhat different from what they were a generation ago. Those who had poor feet then still have them, for the most part. It is reported that nine out of 10 persons over 50 years of age have foot defects. In the Army, flat foot is still the commonest cause of retirement for bodily disability, but it is not now the commonest cause for rejection of recruits; it is exceeded by both defective teeth and defective eyesight. In one series of examinations, in which 1700 recruits were accepted, only one was rejected for flat foot.

It appears that those who were children when the widespread interest in feet first began have grown up with feet in much better condition than were those of their parents at the same age. Among college freshmen many reports indicate that the conspicuous defects of former times are now conspicuous by their absence.

Nevertheless physicians are by no means satisfied with the present status of the feet; many young men and women even now show some of the faulty habits of foot use that will eventually cause trouble. One physician who recently examined thousands of children between the ages of 8 and 14 found definite evidence of beginning foot defects in 80% of girls and 65% of boys. It appears to be quite as important as ever to stress pre-clinical aspects of foot disorder. In the experience of many physicians, the measures to be mentioned have particular value when applied before the feet begin to cause trouble.

Architecture of the Foot.

As will be seen in Fig. 144 the feet and ankles are anatomically very similar to the hands and wrists. The long bones from toes to ankles (metatarsals) correspond with the long bones from fingers to wrist. Both ankle and wrist consist of a number of irregularly shaped bones, rather firmly held near to each other, but movable within a narrow range. The chief motion in each case is flexion and extension of the whole hand or foot in relation to arm or leg respectively. Both structures may be turned on the same plane so as to point toward the central axis of the body or away from it. The hand may be turned so that the palm faces upward (supination) or downward (pronation); the foot has more limited motion in these directions.

a. Distribution of Weight.—The lateral view of the foot, as in Fig. 145, shows that the bones of the foot form an arch from the ball to the heel. The ends of the leg bones rest upon the apex of the arch. Body weight from above falls upon this apex, and from there is distributed to both ends of the arch. At the front of the foot, the weight is distributed across the entire ball of the foot to the head of each of the metatarsal bones. The weight-bearing structure may therefore be visualized as a sort of tripod, with its base a triangle whose three points are the heel, the base of the large toe, and the base of the small toe. In standing, half the weight of the body is distributed to each foot, and half of that to each heel, the other half being distributed to the heads of the five metatarsals.

b. Support of the Foot.—The various bones of the feet are held in close relationship to each other by ligaments between each bone

and others, and by certain strong ligaments from the toes to the heel, connecting the two ends of the arch, like bowstrings. The arch of the foot is similar in principle to the arch of a bridge; the curved

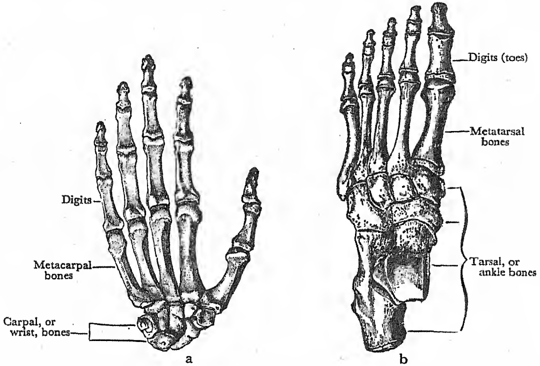


FIG. 144.—The bones of the hand (a), and of the foot (b). Note that the differences are chiefly in relative proportions. (Bundy.)

formation furnishes great strength for the weight applied from above, and at the same time gives resilience. The plantar (sole) ligaments normally prevent the arch from being too much flattened under weight bearing. The small muscles of the feet also aid in the support of the bones in proper relationship to each other.

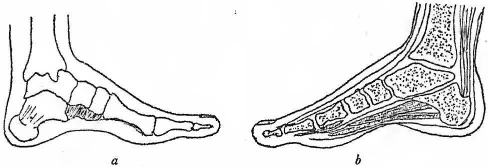


FIG. 145.—Lateral views of the foot: (*a*) bones; (*b*) bones, with some of the muscles and tendons.

A considerable amount of support of the foot is furnished by the tendons extending into the foot from the muscles in the legs. (Many of these tendons can be seen and felt as the muscles of the

It appears that those who were children when the widespread interest in feet first began have grown up with feet in much better condition than were those of their parents at the same age. Among college freshmen many reports indicate that the conspicuous defects of former times are now conspicuous by their absence.

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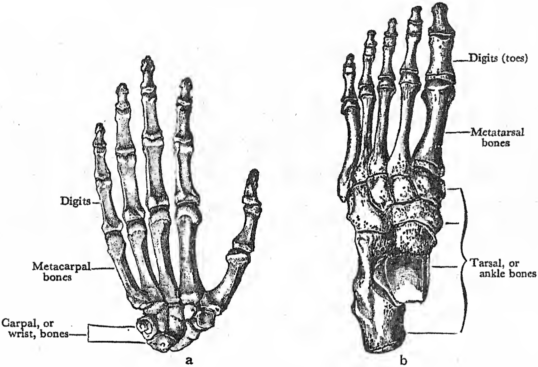

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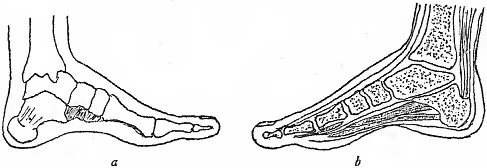


FIG. 145.—Lateral views of the foot: (*a*) bones; (*b*) bones, with some of the muscles and tendons.

A considerable amount of support of the foot is furnished by the tendons extending into the foot from the muscles in the legs. (Many of these tendons can be seen and felt as the muscles of the

leg are contracted.) Two of these tendons are of special importance as lateral buttresses of the foot; they pass just behind the ankle prominences, which contain grooves in which the tendons slide as in a pulley, and are attached to the under side of the bones of the feet. Their function is that of steadying the foot in the upright position, to keep it from rolling from side to side.

Fig. 146.—Muscles of the leg, showing tendons in the foot. (Potter Compend of Anatomy.)

c. Motion of the Foot.—Motion of the foot is controlled to a small extent by small muscles in the foot itself, but the greater part of the motion of the foot is due to contraction of muscles in the legs (as can be demonstrated by making almost any foot or ankle motion and feeling the muscles in the calf and the front of the leg contract).

Appearance of the Normal Foot.

In its anatomically and mechanically correct position while standing, the following features are characteristic.

First, the foot will touch the floor on its outer border, but the inner border from ball to heel will be slightly raised from the floor. (Exceptions occur in the case of infants, in whom the arch formation does not take place until after walking begins; and in the case of those whose feet are congenitally not capable of arch formation. In the latter, the entire sole of the foot may be in contact with the floor, and yet the structure of the foot is such that it performs normally in that position.)

Second, the central axis of foot, ankle and leg will be a straight line. When viewed from either the front or the rear the ankle will appear upright. The prominences on the inner and outer sides of the ankle will be equally prominent; a line dropped from either prominence will fall at the margin of the foot, neither inside nor outside the margin.

Third, the foot will remain approximately the same length and width when weight is borne on it as when at rest.

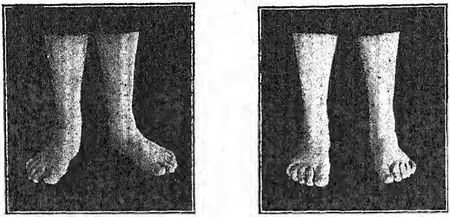
Fourth, the toes will lie side by side, each in a straight line with the metatarsal bone with which it articulates; they will be slightly curved toward the floor and there will be a suggestion of arch

formation across the ball of the foot, increasing as the toes are more firmly flexed.

Fifth, the normal foot will usually be free from corns and calluses; which are evidence of pressure and due to faulty use of the feet or to faulty shoes, or both. (See page 159.)

Pronation.

The commonest abnormality of the foot is that of pronation, which consists of rolling the ankle inward. When viewed from the front the inner bony prominence of the ankle is conspicuous, and a line dropped from its convexity would fall on the floor rather than on the margin of the foot. The inner side of the foot from ball to heel is low; it approaches, or even touches, the floor. These charac-



a *b*

FIG. 147.—Pronated feet, front view (*a*); the same feet after training (*b*). (Girl twenty years old.)

teristics may be noted in Fig. 147. When pronounced, pronation is commonly known as "flat feet" or "fallen arches."

Mechanically, pronation places the foot at a disadvantage. The weight of the body falls on the apex of the arch, but the apex has moved inward, so that the whole weight-bearing tripod is on a slant. Body weight is therefore not properly balanced squarely over the bones that are calculated to bear it, but falls too heavily upon the soft structures at the inner side of the foot.

It has been estimated that an individual weighing 150 pounds drives 178 tons of bodily weight upon his feet every mile he walks. In those who pronate, virtually none of this weight falls where it should. The result is that the foot becomes distorted at many of its joints; they "give" more than they should, ligaments and tendons become stretched, and often the joints become inflamed and painful.

The motor result of pronation is instability of the foot in standing and especially in motion. This is the condition that is usually present in those who have "weak ankles," that turn frequently and that do not permit of such sports as skating.

Secondarily, body mechanics as a whole may be disarranged as a result of disarrangement in the weight-bearing structures.

It is because of its unfortunate motor results that the feet are of such importance in armies. Napoleon said "An army with sore feet is half defeated." The only remedies in former times were soothing external applications and massage. These were used even for the warriors of ancient Greece and Rome. Today we know that valuable as these measures are, they do not correct the underlying mechanical difficulty.

Cause of Pronation.

Pronation is thought to originate most frequently in muscles and ligaments that are relaxed as a result of malnutrition or sickness. In some cases a relative weakness of the foot occurs when the foot structures remain of the same strength but the weight increases; nearly all of the obese develop foot troubles. In infancy, fat babies who learn to walk early and are permitted to walk much may fail to balance the foot properly and may stretch ligaments and tendons. Probably more often than not, a single poorly fitted pair of shoes may be the initial cause of throwing the weight too much toward the inner side of the foot. Overuse of the feet apparently never weakens them if they are strong at the start and are used in the correct position. When overuse does harm it is because imbalance of the foot has already begun.

Increase of Pronation.

Once pronation has begun it has no tendency whatever to cure itself spontaneously; in fact, it tends to increase. The reason for this is clear; the tendon that passes down the inner side of the ankle and is attached to the under side of the foot becomes stretched as additional weight is thrown upon it; and the more it stretches, the more the inner border of the foot sags, and the more weight falls on it—with progressively more stretching. This constitutes a vicious circle, which must be broken into if the function of the foot is to be preserved.

Correction of Pronation.

In the foot that is anatomically normal and only functionally weak in its supporting structures, pronation may be corrected in

its early stages by a definite effort to carry the ankles upright and to keep the weight of the body balanced over the bony weight-bearing area.

To accomplish this result, one may do the following exercise. Stand with the bare feet parallel about four inches apart, with the heels and balls of the feet held firmly on the floor, with the toes flexed as if to grasp the floor; without lifting the balls of the feet throw the weight of the body on the center of the foot as shown in Fig. 147*b*. In order to be certain of shifting the weight as far as the center, it is well to aim beyond the center—that is, to try to throw the weight upon the *outer* side of the foot.

While doing this exercise it is desirable to think of the tendon supporting the inner side of the foot, and to try to contract the leg muscle in such a way as to pull this tendon taut so that it can exert its beneficial lifting effect upon the inner border of the foot.

The exercise should be done a number of times in succession, preferably before a mirror to make sure that the ankles actually are brought to an upright position. Still more important, there should be daily practice in using the foot in this position for standing and walking.

Nearly everyone has sufficient muscle power to hold the ankles upright, but it requires a certain amount of practice to make use of it habitually in this way—and this may be as true of the athlete as of the weakling.

Once the correct use of the leg muscles has been learned, the correct alignment of the bones of the feet and the ankles permits of keeping them in that position with the minimum of muscle effort.

Eversion.

Those who pronate usually evert the foot or "toe out." The infant when it first begins to walk toes in, and later straight ahead. But at any time when the feet begin to weaken, eversion begins, probably as an unconscious attempt to widen the base on which the weight is carried, and thereby to steady the gait made uncertain by the weakness of the ankles.

Toeing out has the effect of stretching the important tendon already mentioned as the buttress of the foot on the inner side. Therefore it accentuates pronation. It is impossible to correct pronation with the feet everted, or vice versa.

Formerly children were actually taught to toe out; even gymnastic exercises were done from that position. Boxers and fencers were the first to appreciate that a forward pointing position of the

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feet gives the strongest base from which to act. Within a generation that position has been adopted in the Army and in most schools. Toeing out persists at present chiefly in dancing schools.

Those who toe out often "knee in," so that the patellas (kneecaps) face slightly toward each other instead of straight ahead. In some cases, "knock-knees" are due to this cause and are curable by knee practice combined with foot practice.

a b

FIG. 148.—The foot prints as they should appear (a) and as they should not appear (b). (The Woman's Press.)

The Use of the Toes.

Much mechanical power is obtained through the use of the toes in both standing and walking and in all propulsive use of the feet. The large toe should furnish more than half the total foot power in propelling the body forward. In times of stress the toes are automatically and reflexly brought into action.

The Anterior Arch.

When the toes are used in a grasping motion, an arch appears across the ball of the foot, which is an advantage for weight-bearing. The phenomenon may be observed in the corresponding structures in the hand. At rest there is a slight arch across the hand at the knuckles (which correspond to the heads of the metatarsals at the ball of the foot). If the hand be placed flat upon a table, the arch disappears, but if the finger tips are gripped against the table, it reappears.

In the case of those who do not use the toes, the heads of the metatarsals receive more weight than they should, since none of it is distributed beyond them to the toes. The extra pressure of these bones on the surface beneath often causes calluses to appear under them, especially under the second and third. Also, the nerves between the heads of the metatarsals may be pinched, causing pain.

The arch formed by the heads of the metatarsals is seen so seldom in the foot at rest that some physicians believe it to be a functional arch only—that is, one that appears only in action. However, some of these who see a great many approximately normal feet, as in college students, do frequently see a slight but definite anterior arch when the foot is at rest. In others it appears when the toes are flexed, and in still others it does not appear in

any circumstances. In the latter, the condition is described as "flat anterior arch." The remedy in the early stages is practice in toe gripping exercises and in using the toes in walking and standing.

Rules for the Use of the Feet.

Three principles for the use of the feet have been stated, and from them the three following rules may be formulated.

1. Keep the ankles upright.
2. Point the toes straight ahead.
3. Grip with the toes.

A fourth matter is of great importance—that of wearing well-fitted, suitable shoes.

Shoes.

A great many difficulties with the feet originate with shoes that do not fit the feet of the wearer. Most of the shoes now on the market for children, boys and girls, and men, and the sport and walking shoes for women cannot be criticized as shoes; but many of the shoes on individuals' feet are subject to much criticism as to the way they fit the individual who wears them.

Poor fitting of shoes is probably due to the fact that the classification of shoes according to length and width misleads many people into thinking that neither feet nor shoes differ in any other respects. Feet have many more dimensions than length and width, and it is not possible to make feet fit into shoes that are not similar to them in all dimensions without doing the feet harm. Therefore obtaining shoes that fit is for most people—or should be—a matter requiring detailed attention.

When shoes really fit they seem to belong to the feet. They do not feel like foreign objects either hanging to the feet or bound around them, but more like another layer of skin—and this may be as true of calf shoes with heavy soles as of the lightest kid shoes with turned soles. It is a matter of fit rather than of materials. One should expect to have shoes comfortable. Beyond that, one should expect shoes not to injure the feet and not to interfere with their free use according to the mechanical principles which have been mentioned.

The following list of questions may be asked regarding shoes that are in use and shoes about to be purchased.

1. *Are they the right length?* The measuring sticks used by shoe salesmen are only an approximate guide. They should, of course, be used to measure both feet, since one foot is usually somewhat longer than the other. The measurements should be taken when the

entire weight is being borne on the feet, since weak feet spread in both length and width, in "splay-footed" fashion, when in use.

The shoe should usually be 2½ sizes longer than the longest foot measures when one is standing. In some shoe stores, an x-ray device is used for visualizing the feet in the shoes; the tip of the large toe should be about ¾ inches from the end of the shoe. The height of the box of the shoe over the toe makes a difference in the length required; if the box is low it has the effect of shortening the shoe, since the edge of the nail may hit the box as it slopes downward.

In shoes that are the right length the widest part of the foot comes at the widest part of the shoe; the large toe joint lies where the sole of the shoe is widest; and the shank of the shoe lies closely against the sole of the foot. Usually the upper part of the shoe fits better if the shoe is of the right length.

In general, there is less danger of wearing shoes too long than too short, unless they are so long that they fit poorly throughout. Too short shoes are the cause of a great deal of foot trouble. Incidentally, it should be mentioned that short stockings may cramp the toes almost as much as short shoes.

Because the lasts of shoes vary so greatly, shoes of the same number may be apparently of different length; therefore the final test of the length of shoes is walking in them and making sure that they feel fully long enough.

2. *Are they the right width?* Comfort is a fairly satisfactory guide to width. Perhaps the greatest danger in the case of sensible people is that of buying shoes that are too wide. Too narrow shoes hamper foot action, but so also may shoes that are so wide that they slip. In general, a shoe of the correct width creases horizontally when one walks in it, whereas the creases made by bending the foot in a too wide shoe are diagonal from the region of the large toe to the small toe.

3. *Do they fit well at the heel?* The counter (the stiff part of the heel) should fit closely to the foot but exert no pressure. Shoe manufacturers make "combination lasts" with the heel proportionately narrow for those whose feet show this characteristic. In walking, the back part of the shoe should remain with the foot, not slipping at the heel.

4. *Does the upper edge of the shoe fit well?* There should be no gaping of the shoe at the top; it should touch the foot all around. Gaping almost always indicates that the shoe is either not the right size or

not the right last. Conversely, there should be no pressure at the top of the shoe, especially at the back. A not uncommon injury caused by such pressure is an inflammation of the bursa of the large tendon (tendon of Achilles) at the back of the heel.

5. *Does the shape of the shoe permit use of the toes?* A shoe should be shaped so as to permit the toes to lie straight and parallel and to be used in a gripping motion.

Although this applies to all the toes, it is of special importance in respect to the large toe. If this toe is crowded outward, toward the other toes, its joint may become inflamed and eventually enlarged, causing the condition known as bunion. A bunion is painful and is difficult to cure without a surgical operation. It usually results from wearing shoes that are too short and at the same time have an inner margin that deviates toward the center of the foot. The sole of a shoe should always be inspected to make sure that its inner margin is very nearly a straight line from heel to toe.

6. *Does the shoe fasten firmly around the waist of the foot?* This is a very important point in shoes that are to be used in walking or any other activity except ballroom dancing. Lacings furnish the firmest support. In new shoes the lacings should not bring the edges of the shoe together, or they will fail to serve their purpose after the shoes have stretched in use. It should not be possible to put shoes on, or to remove them, without unlacing them. The pressure exerted by lacings is borne by the shafts of the metatarsal bones, and serves to keep them from spreading apart unduly when weight is thrown upon them. This is the only part of the foot where any degree of tightness is permissible, and here it is desirable.

7. *Is the heel of suitable height and width?* Suitability varies according to the use to which the shoes are to be put. A low heel is distinctly preferable for walking purposes. In fact if one walks much in high-heeled shoes, the feet are likely to be seriously damaged in a good many ways. There appears to be universal agreement that the wearing of high heels by women is the chief reason for the greater prevalence of foot troubles among them. The damage occurs, of course, as a result of throwing virtually the entire weight upon the front part of the foot. For example, in a woman weighing 120 pounds, nearly 60 pounds of weight (instead of the usual 30) would fall upon the front of the foot at each step. Man generically is a plantigrade animal, walking on the sole of the foot, as distinguished from such animals as the horse that walk on the toes and are

therefore digitigrade. Very high heels require that the human foot be used somewhat after the manner of the horse; and the human foot is not adapted to such use.

Aside from their effect upon the foot itself, high heels tend to throw the whole body out of alignment because of the compensatory bending of the knees, hips and spine. Balance throughout the body is therefore disturbed. One of the hazards is that of accidents due to such lack of balance. In a series of industrial accidents among women, half of them were directly traceable to high heels.

It is generally agreed that for street purposes heels should usually be not more than 1½ inches high, and nearly as broad at the base as the top. In dancing, the use of high heels does little harm, since the weight falls on the balls of the feet in any case, although not heavily as in walking.

The wearing of flat-heeled shoes is never harmful to a person who uses his feet properly, but sport shoes and sneakers may permit too much relaxation in the case of those with weak feet that have already begun to pronate, or in those who do not know how to use their feet properly. This is especially true if such shoes are too loose and are not fastened closely around the waist of the foot. Special care is needed in the fitting of flat-heeled shoes, and in the use of the feet while they are being worn.

In connection with heels, it may be mentioned that when they wear off on the outer side it is not an indication that the weight is carried on the outer side of the foot, as might appear to be the case. Instead it is usually an indication that the foot is pronated and everted, and that the outer side of the heel is put down first at each step. To keep the heels square the wrong thing to do is to throw the weight on the inner side of the foot, which will increase the pronation. The right thing to do is to throw the weight toward the outer side and to toe straight ahead.

8. *Does the shoe permit one to carry the ankle upright?* This is a final and important question. A shoe may be correct in every respect mentioned, and yet when one stands and walks in it, it may be difficult or impossible to keep the weight over the center of the foot. Since many people pronate and will continue to do so, some of the shoes on the market are made for pronators. They will not fit a person with normal feet, nor will they give any assistance to one who is trying to train his feet not to pronate. Shoes are available, however, in which it is possible for the normal foot to be used correctly.

The question sometimes arises whether it is desirable to make use of shoes in which the shank is stiffened by metal. Certainly nothing in the way of an arch supporter should be used without medical advice. Useful as they may be in some cases, it is usually better for the young person with plenty of muscle power to cultivate the correct use of the feet in the ordinary well-fitted shoe.

In case of any unusual mechanical difficulties with the feet, it is desirable to consult an orthopedic specialist—the "engineer" in regard to matters of body mechanics.

Walking.

Walking should be a series of falls from which one saves himself by bringing the rear foot forward in time. Many people carry themselves in a position to fall backward, the body being balanced to the rear rather than to the front. It is incorrect to put one leg forward while keeping the weight on the rear one. The weight should move forward with the forward-moving leg, so that when that leg touches the ground the weight is all ready to fall upon it.

Some good walkers believe that they touch the ball of the foot to the floor first; others, the heel. All agree that the weight should not fall heavily on either part, but in the brief time each foot is on the ground the weight should be consecutively on all parts of it, with each step ending on the toes.

Many people do not bend at all at the ankle in walking, but walk with their feet passively flopping or dangling, or woodenly fixed, at the ends of the legs. The feet should not be lifted and put down as a whole, but in a "heel-toe-heel" fashion. Most awkward gaits are due chiefly to lack of motion at the ankle, and lack of bending within the foot, especially at the joints of the toes, at every step.

An easy gait consists of a continuous gliding motion of the body without hitching or swaying of the hips or shoulders, or paddling motion of the arms, or jerky over-straightening of the knees, or limp, incomplete straightening at the knees and groins. An awkward or clumsy gait can usually be corrected by practice based on improved use of the muscles throughout the body, better distribution and balance of weight, and the already mentioned better use of the feet and ankles.

Chapter 38

THE EYE

The visual apparatus consists of the eyes themselves; the optic nerves, one of which is attached to each eye; and the visual centers in the brain, to which the optic nerves extend. Vision depends primarily upon the ability of the receptors of the optic nerves to respond to light. These receptors are located in the interior of the eyeball.

The Eyes.

The eye is an optical instrument not unlike the camera in principle. It is a globoid structure, enclosing fluid. Its walls are

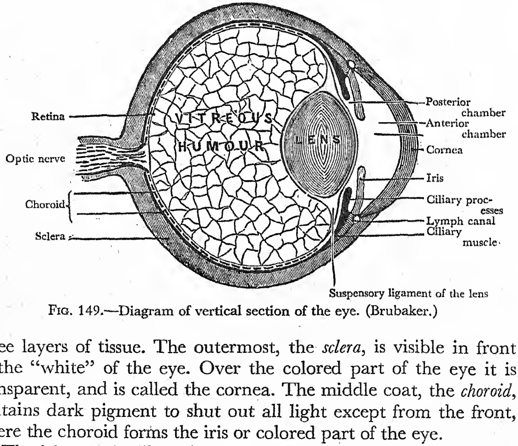


FIG. 149.—Diagram of vertical section of the eye. (Brubaker.)

three layers of tissue. The outermost, the *sclera*, is visible in front as the "white" of the eye. Over the colored part of the eye it is transparent, and is called the cornea. The middle coat, the *choroid*, contains dark pigment to shut out all light except from the front, where the choroid forms the iris or colored part of the eye.

The iris may be likened to the diaphragm in a camera. It contains an opening called the pupil which varies in size according to the amount of light to be admitted and according to the distance

of the object looked at; it enlarges in dim light and for distant vision, and contracts in bright light and for near vision. The size of the pupil is controlled by muscle fibers in the iris—circular fibers around the open margin make the pupil smaller, and radial fibers from the margin to the periphery make it larger.

The third coat of the eye is the *retina*, in which the receptors of the optic nerve lie. These receptors are known as rod cells and cone

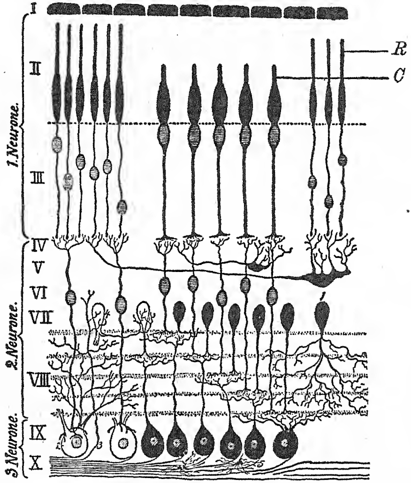


FIG. 150.—Diagram of the structure of the human retina (Greeff); I, pigment layers; II, rod and cone layer; R, rods; C, cones; III–IX, intra-retinal nerve elements; X, axons which pass to optic nerve. (Martins "Human Body," Courtesy Henry Holt & Co.)

cells (see Fig. 150). They contain chemicals analagous to the chemicals in the camera plate or film. Light creates changes in these chemicals, but the instant one impression is recorded, the retinal chemicals are renewed and ready to receive other impressions. Vitamin A is present in the retina if taken in sufficient amounts in the diet, and is concerned in the regeneration of one of the chemicals, "visual purple." In its absence, vision in dim light is impaired.

Refraction.

Just as in the camera, the eye contains a mechanism for focussing the rays from objects so that a clear image is possible. In the camera, focussing is accomplished by moving a lens forward or backward. In the eye there is a lens, but it adapts to the need for focussing light by becoming thicker or thinner.

The *lens* is located just behind the pupil. Because it is a transparent refractile structure, curved on both surfaces, rays are bent or refracted as they pass through it, so that they converge behind it. To give a clear image, rays must focus exactly on the retina. If the lens could not change in thickness the rays from a given distance would focus upon the retina and all others would not.

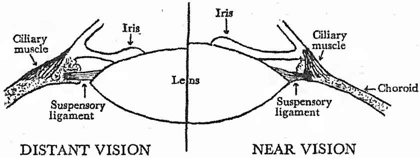


Fig. 151.—Diagram illustrating accommodation. To the right, the ciliary muscle is contracted, the suspensory ligament is relaxed, and the lens thickens, as for near vision. To the left, the normal eye in distant vision. This diagram also shows the contraction of the pupil for near vision; note distance of iris from center line on each side.

The mechanism for changing the thickness of the lens consists of a circular ligament attached all around the margin of the lens and also to the choroid coat of the eyeball, and to a circular muscle, the *ciliary muscle*. Contraction of the ciliary muscle has the effect of relaxing the ligament, which is followed by thickening of the lens, in which case rays focussing behind the retina are brought to a focus farther forward. This is called the act of *accommodation*. It takes place in the normal eye when nearby objects are looked at. The reverse process—relaxation of the muscle with flattening of the lens—occurs when normal eyes are being used for distant vision.

Binocular Vision.

The use of two eyes simultaneously widens the range of vision. Also, the sense of perspective is thereby made possible. Each eye obtains a very slightly different visual impression of any object looked at. With experience in interpreting these slightly different impressions, it is possible to estimate size, distance, rate of motion, and the like. An individual with vision in only one eye cannot safely undertake such work as driving a car (see page 172).

Optical Effectiveness of the Eyes.

To see well, the visual centers in the brain, the optic nerves, and the retina must be intact; and to transmit light to the retina, the eye must be effective as an optical instrument. It must admit rays of light and focus them precisely upon the retina from whatever distance they come. To admit rays of light, the structures through

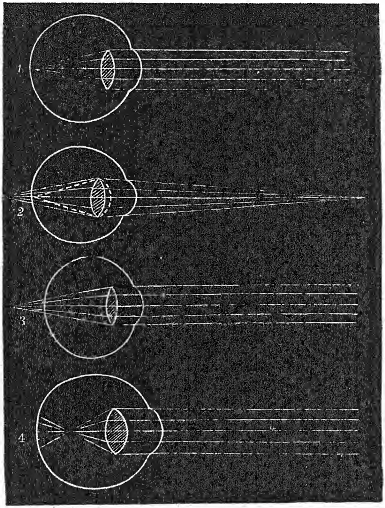


FIG. 152.—1. Normal eye; rays focusing on retina. 2. Normal eye adapted to near vision by accommodation, bringing rays to focus on retina. 3. Farsighted eye; note lack of depth. 4. Nearsighted eye; note increased depth. (From Halliburton, "Physiology.")

which light passes must be transparent. To focus, the lens must be capable of changing its shape, and the ciliary muscle must be strong enough to bring about such changes. Last, but not least, the eyeball must be of a particular shape, so that changes in accommodation do result in bringing light to a focus on the retina, and without strain of the ciliary muscle. Such an eye is said to be *emmetropic;* accommodation is used for near vision, but not otherwise.

Refractive Errors.

This term implies that light rays are not refracted as they should be to cause them to fall upon the retina, or are so refracted only as a result of strain of the accommodative mechanism.

The refractive errors are *hyperopia* (farsightedness); *myopia* (nearsightedness); *astigmatism;* and *presbyopia.* These four refractive errors account for by far the largest part of poor vision. Hyperopia is the most common of all. Everyone is born farsighted, and many remain so.

Hyperopia.

In farsightedness the eyeball is too flat, never having grown to its normal depth. Rays focus behind the retina, but an effort of the ciliary muscle brings both near and far objects into focus. The farsighted person, therefore, is likely to see well and not to realize that he has this defect until he has wearied the ciliary muscles by using them constantly. At such a time the eyes begin to give trouble. This defect should be discovered in time to prevent eyestrain.

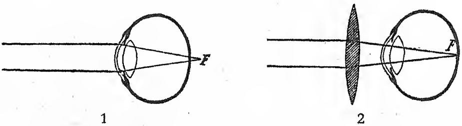


FIG. 153.—Hyperopia, or hypermetropia, farsightedness; 1, parallel rays focussed behind the retina. 2, correction by means of a convex lens. F, focal point; L, lens in front of eye. (Brubaker.)

Convex lenses correct farsightedness by converging the rays and bringing them to a focus farther forward. This relieves the ciliary muscle of its need for constant action and limits its work to that which it has to do in normal accommodation. With proper glasses the farsighted do not see as well at a distance as without glasses; but they are working their eyes within normal limits and seeing as clearly as a normal eye should.

Myopia.

In myopia the eyeball is too deep from front to back, with too great distance between the lens and the retina. Light from a distance focusses in front of the retina and only objects that are close to the eye are seen clearly. Distant vision cannot be improved by the work of the ciliary muscle, since the accommodative mechanism

brings light to a focus farther forward. The only way in which distance vision can be improved is by the use of a concave lens in front of the eye. This spreads the rays and brings them to a focus upon the retina.

The nearsighted person who does not wear glasses does not suffer from strain of his accommodative mechanism, but may suffer from intraocular congestion if the eyes are used too much for close work, especially if the best point of vision is very near to the eyes.

In some persons, the deepening of the eyeball continues, giving progressively increasing myopia. Unless corrective lenses are worn

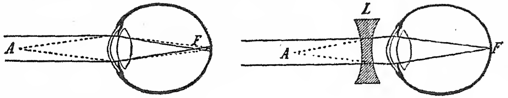


FIG. 154.—1. Myopia, nearsightedness; parallel rays focus at F, cross, and give blurred vision. Divergent rays from A focus on the retina and give clear vision. 2. Correction of myopia by a concave lens. (Brubaker.)

and the eyes used only under favorable conditions, eyesight may be lost.

Astigmatism.

Irregularity in the curves of the cornea cause rays to be bent in different directions, and not to come together in exact focus at any one point on the retina. Vision is blurred, although the individual may not know it, never having had any clearer vision. This defect often occurs in combination with farsightedness; less often, with nearsightedness.

Correction of astigmatism is by compound lenses ground so as to counteract each of the various optical defects—that is, the glasses are more curved where the cornea is less curved, and vice versa.

Presbyopia.

Beginning at about forty years of age, even the hitherto normal eye loses some of its power to converge rays exactly on the retina, because the lens loses some of its elasticity and will not thicken so as to give clear vision for near objects. Distant vision remains good, but convex glasses are required for near vision. The first evidence of loss of accommodation from aging of the lens is the need of moving fine type farther away from the eyes in order to make it

clearer. By the age of fifty, much of the power of visual accommodation has usually been lost.

Eyestrain.

Eyestrain may occur in normal eyes as a result of abuse, but it is particularly likely in the case of those with a refractive error not corrected by glasses, or poorly corrected. It may be present when vision appears to be good, as in the farsighted.

The effects of eyestrain may be felt in the eyes (pain, itching, dryness, watering, etc.); or may show in their appearance (red lids, "bloodshot" eyeballs, puckered brow, a strained expression, wrinkles around the eyes, etc.); or may give symptoms elsewhere ("nervousness," headaches, lack of ability to concentrate on psychovisual work, etc.). Either drowsiness or restlessness while studying may be due to eyestrain. Sometimes the necessity for long hours of sleep may be due to a demand for a long recuperative period on the part of strained eyes. Sometimes the reverse, insomnia, is present. "Nervous breakdown" has been found in some cases to be based upon eyestrain.

Since the modern development of the science of optics, the world has profited by the work of many who in former days would have been hopelessly disabled as a result of poor eyes. Few are like Darwin, who kept endlessly at his work in spite of the life-long eyestrain which physicians now think must have been the cause of his succession of "sick headaches."

Although the symptoms of eyestrain are often unpleasant, the significant point is that the eyes may be harmed. Visual power may be weakened and the length of life of the eyes shortened. Both the prevention and cure of eyestrain involve the use of glasses if necessary, and in any case, the use of the eyes only under suitable conditions of lighting and posture.

In the case of the vast majority of individuals there is no objection to using the eyes practically all one's waking hours, even for close work most of that time, if the conditions under which they are used are favorable. Only a few individuals need to limit their work out of consideration for the eyes, and most of these need not have arrived at that point had they, all along, been particular to avoid definite abuse.

Examination of the Eyes.

All children should have the eyes examined before entering school, and periodically thereafter until the age of twenty. This should be the procedure even though no defect is ever found,

for the eyes may change from year to year during the period of their growth. Certainly no student should ever attempt college work without having had a recent ophthalmological examination.

At any time in life, the eyes should be examined if they show signs of inflammation or of fatigue at or after work. Finally, they should be examined if in the opinion of one's physician there is evidence of eyestrain. The best available ophthalmologist should be chosen for this highly specialized examination.

To examine the eyes properly, the ophthalmologist often finds it necessary to do away with the action of the muscles of accommodation temporarily. This is accomplished by the use of drops of belladonna or atropine. In certain diseases of the eyes there is danger in using such drops; hence their use is not permitted by any but physicians, who will not use them except when they know them to be (as they usually are) absolutely safe. For a few days after "drops" have been used, near vision is poor, and the eyes must not be used until the ciliary muscle returns to its former status, and vision is clear.

Eyeglasses.

In former times glasses were worn only when vision was obviously defective. Now they are worn often by those whose eye defects are slight (*a*) to prevent future more serious harm, or possible loss of vision; and (*b*) to prevent the nerve strain and bodily ill health that so often accompanies eyestrain.

When glasses are needed, no other measures will suffice. They are not ordinarily curative, but are a means for avoiding strain and premature deterioration of the eyes. It often happens that the eyes strengthen as health improves or as habits of using the eyes improve, and that the ocular strain that was present when glasses were first prescribed is relieved by the use of glasses, thus making the eyes more capable of use. Therefore it is sometimes possible to become less dependent upon glasses after wearing them for a time, but seldom to abandon them altogether if a refractive error is present.

One should have no fear that physicians will prescribe glasses if they are not needed, nor that any correctly prescribed glasses will do anything but help the eyes to do their work more easily and preserve their health. When glasses are needed, a physician usually writes a prescription for them, with the instructions to have the prescription filled by an optician.

The optician's work is that of grinding the lenses according to the prescription and fitting them into frames that will hold the optical center of the lens exactly in front of the pupil of the eye. This is important, for even a slight displacement will do away with all the value of the lens, especially in the case of the compound lenses for astigmatism. After receiving the glasses, one should take them to the physician for his final verdict on their correctness.

Eyeglasses must be kept perfectly clean, and in perfect adjustment on the nose.

EYE DISORDERS

Blindness.

It is reported that there are 100,000 persons in the United States who are blind to the extent that they cannot count fingers held three feet from the eyes. The causes are numerous, with *infection* of one sort or another involved in many cases. The venereal diseases syphilis and gonorrhea together account for a larger proportion of blindness than any other single cause, with tuberculosis third among the infections. Syphilis alone causes 15% of the total blindness. The lesion in all three of these diseases is likely to involve the cornea, causing opacities. Any of the pus-forming germs may have a similar effect. Syphilis may also involve the optic nerve.

Accidents in industry, and accidents to children while at play, are nearly as frequent causes of loss of vision as is infection.

Aside from external causes, three causes from within may lead to blindness if the condition is not properly cared for. *Myopia* in some cases is progressive, until ultimately scarcely any visual power remains. Only a small proportion of nearsightedness is of this progressive type. Even in such cases much may be done to delay the progress of the disease. Those so afflicted may often be protected against blindness by such training as is given in "sight-saving" classes and by care in the choice of vocation and avocations. *Squint*, or "cross eyes," if uncorrected may lead to blindness in one or both eyes (page 599). Glaucoma (page 602) is responsible for 12% of blindness.

The Eye Muscles.

The motion of the eyeball is produced by a set of six muscles, so arranged that the eye may be turned throughout a wide range. The corresponding muscles of each eyeball normally act in unison, so that both eyes are turned on the same object at the same time. These are called the external ocular muscles to distinguish them from the ciliary muscles located internally.

If these muscles are not of balanced strength, the eyeball is not held in the direction of vision, but turns either inward or outward, giving the condition known as squint. The cross-eyed person does the greater part of his visual work with one eye, and the "turned" eye loses its vision partly or completely.

Squint usually appears before the sixth year. If attention is given to it promptly, vision may be saved in a great many cases, by glasses and by training. In other cases the remedy is surgery. At any time in life when squint appears or is present, it should be investigated by an ophthalmologist.

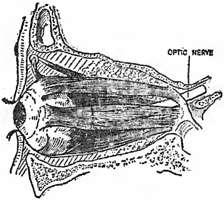


FIG. 155.—The muscles of the eye. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

The Lacrimal Glands.

The lacrimal or tear glands are located at the outer upper corner of the orbit. They open by a number of ducts upon the under side of the upper lids. They secrete constantly, but the excess is ordinarily drained off imperceptibly by a duct from each orbit to the upper part of the nasal cavity.

The lacrimal secretion serves to moisten the eyeball, and also it has a disinfectant action. It is secreted more freely in reflex response to the need for additional moisture to wash away dust and the like. Strong light, cold, and several other factors, including emotion, may affect the amount of secretion. Disease of the lacrimal glands and ducts is comparatively uncommon, but when it does occur it urgently requires treatment. In the disease xerophthalmia, due to vitamin A deficiency, the secretion is decreased, and the dryness of the eyeball leads to infection.

Accidents to the Eye.

A "black eye" is the result of contusion of the soft parts around the eyeball. Ordinarily it is not serious. If cold water is available at the time of the injury it may limit the discoloration. Later, hot compresses are likely to be more beneficial.

After a blow to the eye, whether or not it becomes discolored, medical aid should be secured without delay if there is any loss of vision, for detachment of the retina from the choroid may have occurred, and blindness in the eye may result, especially if treatment is postponed.

A wound of the cornea is particularly serious because of the opacity of the scar tissue by which healing takes place.

Foreign Substance in the Eyes.

When dust or any larger particles enter the eyes the normal result is an increase of secretion from the tear glands, which washes the foreign matter out over the lids or down through the duct to the nose. This will happen (unless the particle is deeply embedded) if one immediately closes both eyes and keeps them closed loosely, without rolling the eyeball, for a few moments. The eyes should not be rubbed, or any other procedure used except that mentioned. Many of those who present themselves to physicians to have particles removed from the eyes are suffering at the time not from the presence of the particle but from soreness produced by rubbing.

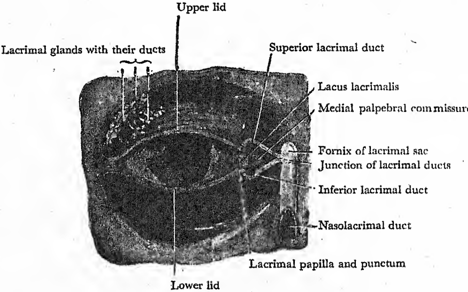


FIG. 156.—The lacrimal apparatus. (Morris' Human Anatomy.)

If a foreign body does not dislodge itself after an interval of waiting, a few drops of 4% boric acid solution from a dropper may wash it away. As a last resort, a bit of sterile absorbent cotton or the corner of a clean handkerchief may very gently be brushed over it, if it is clearly visible. If the particle is not visible, or if it cannot be dislodged easily as described, a physician should be consulted.

Chemicals in the eye—any chemicals—are to be diluted with *water* in large quantities which should be flowed gently over the eye held open by the fingers.

Infection of the Eyes.

Infection of the eyes may occur from the *exterior* (e.g., by means of germ-laden fingers or handkerchiefs) or by *extension* from other infected areas (e.g., nasal sinuses, teeth). Any part of the eye may be infected. The commonest site of infection is the

conjunctiva, the membrane that covers the eyeball and lines the lids. Infection of the *cornea* is nearly as common, and more serious.

The symptoms of conjunctivitis are redness, swelling, discomfort, and increased secretion. One form of acute conjunctivitis is known as "pink eye." Because it is very contagious, any signs of it should receive immediate attention. Ordinarily it is not a serious disease, if properly treated, although it may lead to infection of the whole eyeball, and even to blindness.

During a cold, the conjunctiva is often inflamed because of congestion, but such inflammation may mean infection. The conjunctiva is a part of the same membrane that lines the nasal passages, and infection may readily take place by continuity; or bacteria from the nasal secretions may be transferred to the eyes while rubbing or wiping them.

Some inflammations of the conjunctiva are not due to bacteria but to irritation (from dust, smoke, soapsuds, facepowder, etc.). A more or less chronic sort of non-bacterial inflammation of the eyes is often the accompaniment of eyestrain. Any inflammation of the eyes predisposes to infection.

The most serious purulent infection of the eyes is gonorrhea. Blindness from this cause is not uncommon, for it involves the cornea, which is likely to become opaque as healing occurs.

The disease trachoma, which causes 3% of blindness in this country, is a chronic infection of the lids. It occurs especially in those whose living conditions and diet are poor. Recent reports indicate that it may be curable by sulfanilamide. This is one of the diseases for which alien immigrants are deported.

Styes.

A stye is due to infection of one of the small glands along the margin of the lid which produce an oily secretion for lubrication between the lid and the eyeball. Styes usually occur in eyelids that are inflamed and feel irritated and are rubbed or scratched by the fingers. Since farsighted eyes are particularly subject to eyestrain, and their lids to irritation, styes are more common in them. The superstition that styes indicate strong eyes is founded upon this fact, the error being that of considering eyes strong if they can see unusually well at a distance.

Styes, of course, have the same significance as any infection. The most important point in caring for them is to make sure that when the pus is discharged from them it is not spread about on the lid so as to cause more styes or on the eyeball so as to infect the

cornea. Because that danger exists, it is essential that a stye have treatment by a physician.

Glaucoma.

Glaucoma is a disease which most often appears at or after middle age. It is sometimes a sequel of eye injury or inflammation, but frequently no cause for it can be determined. If blindness from glaucoma is to be prevented, treatment must be prompt. The early symptoms are varied. All persons who observe any abnormality in vision should consult an ophthalmologist. The characteristic feature of the disease is an increase of fluid under tension within the eyeball, with a tendency of the pupil to become fixed in full dilation. It is manifested by changes of vision, and often by inflammation. Either medication or surgery are used in treatment.

PROTECTION OF VISION

The hygiene of vision involves little in everyday life beyond (*a*) being certain of the optical effectiveness of the eyes, with the use of glasses if necessary, and (*b*) using the eyes only under favorable conditions, the most important of which is illumination.

The following points might well be noted, even for those with the strongest eyes. First, during a long session of close eye work it is well to interrupt the work for a moment from time to time and look off into the distance to relax the muscles of accommodation. This is especially necessary during microscope work. Also, it is well for those who use the microscope a great deal to train themselves to use both eyes alternately, and to keep both open.

Second, the position of the body should be such that the neck is not too sharply bent forward during close visual work, whether one is sitting or lying down.

Third, it is well not to try to read fine print on a moving vehicle, because of the constant activity of the external ocular muscles and the apparatus of accommodation that such eye work entails.

Fourth, the eyes should not be used too long, and perhaps not at all, during illness. The muscles of the eyes are likely to share in any weakness of the body, and the eyes thereby are more subject to strain at such times. While ill with an infection with fever, one should preferably rest the eyes both for their sake and to allow plenty of time for sleep.

The hygiene of the eye does not usually entail the use of lotions or drops or ointments or hot or cold compresses or massage, except as prescribed by one's physician. Under unusual circumstances

causing irritation (e.g., exposure to much dust) a few drops of 4% boracic acid solution may safely be used in the eyes, but not for the purpose of postponing consultation regarding frank inflammation. As has often been mentioned in reference to the self-treatment of ailments, the medicine used may not be harmful in itself, but the delay in having expert treatment may indeed be disastrous. This is particularly true in the case of the eyes, which are so easily harmed and so indispensable.

Like all parts of the body, the eyes share in the general state of health. Even the appearance of the eyes reflects illness. One of the indications of a return to health after illness is that dullness of the eyes gives place to sparkle, and a "hollow-eyed" look and dark circles tend to disappear. Still more definite is the effect of health upon the function of the eyes. When good health is present, optical difficulties and muscular weaknesses are at a minimum in their effect on vision; and vice versa.

Illumination.

In arranging a room for study purposes, the desk and chair should be placed in proper relationship to both daylight and artificial lights. The important points are: (*a*) to have sufficient light on the work, but not a glare; (*b*) to have light on the work but not shining in the eyes.

In a report to the Illuminating Engineering Society, Dr. Matthew Luckiesh and Dr. Frank K. Moss of the Lighting Research Laboratory, Cleveland, describe several "thresholds" of visibility, which they call *see-levels*. At the upper see-level, additional light does not aid in the performance of a task but provides for seeing with the least wear and tear on the eyesight. Just below that level, seeing is at the maximum, but not ease of seeing. Below these levels there may be uncertainty about what is seen, and some degree of strain to the eyes in seeing it. The aim, of course, should be to provide illumination at the highest see-level.

When electric light is used it is thought better to have part of it diffuse throughout the room and part of it localized on the work. The most modern artificial lighting is indirect, reflected to the ceiling by opaque shades or mouldings, and from there into the room; or semi-indirect, reflected by semi-opaque shades partly through them and partly from the ceiling. However, satisfactory conditions may be secured by direct light, provided it is shaded so that the bulb itself is not within the range of vision, and does not cause glare on the work.

The number of lumens or foot candles of light required for various kinds of work varies with the fineness of the work, and also with the color of the work and of the surroundings in the room (the darker they are, the more light they absorb).

For average purposes of study, 10 foot candles of light are usually required on the work. Since the strength of the illumination varies inversely with the square of the distance, a tungsten lamp of given wattage at two feet will give only one-fourth the amount of light on the work as at one foot. A 100-watt bulb at three feet gives all the illumination that most people care for. A somewhat smaller amount of localized light would be necessary if enough diffused light were also present.

Ophthalmologists generally agree that subjective tests of the amount of light needed are reliable—that is, the correct amount for a given person under given conditions is that which enables him to see clearly and comfortably. Experimentation shows what that amount is. Light meters are useful in gauging the correct illumination for groups at work in large rooms.

Those who require an unusual amount of light should have their eyes examined. It may be that they need glasses, or it may be that they lack sufficient vitamin A in the diet.

The main objection to reading while lying down—aside from faulty position of the head and of the book—is that it may be difficult to arrange the light so that it gives adequate illumination on the book and does not shine into the eyes. Under proper conditions, reading in bed is entirely safe.

The effect of outdoor light upon the eyes was mentioned in Chapter 33. Briefly, it may be stated here that normal eyes are usually not adversely affected by ordinary exposure to sunlight, but that when and if colored glasses are used they should be of optically perfect glass, obtained from an optician.

Chapter 39

THE EAR

The Organs of Hearing.

Sound is caught first by the *external ear*, a cartilage shaped so as to act as a receiver for sound waves. In animals it may be voluntarily directed toward sounds, but in man the ability to move it thus to his advantage has been lost.

Extending inward from the external ear is the *external auditory canal* to the middle ear. This canal is lined with skin which, in certain areas, contains glands that produce a secretion called cerumen or "wax," a sticky substance that serves to ensnare dust and dirt.

At the inner end of the auditory canal is the main sound-conducting chamber, the *middle ear*. Through its various structures, which will be described in the section on deafness, sound is conducted to the *inner ear* where are the receptors of the *auditory nerve*. Sound is carried by the auditory nerve to the *auditory centers* in the brain, located in the cortex of the temporal lobe.

Deafness.

Deafness may be due to several causes. Rarely it is due to failure of the auditory centers in the brain to perceive the messages sent in from the inner ear, as a result of damage to the brain. It may be due to interference with the reception of sound, owing to disease of the auditory nerve or of its receptors in the inner ear. More often, deafness is due to changes in the middle ear which make it impossible for sound to be conducted to the nerve receptors. Finally, it may be due to closure of either of the two passages to the middle ear, the auditory tube from the throat and the external auditory canal from the outer ear.

A relatively small proportion of deafness is due to disease of the hearing centers in the brain, or of the auditory nerve, or of the inner ear. In the majority of cases, deafness is due to the results of disease of the sound-conducting apparatus of the middle ear. This type of deafness is not only the most common, but also the most preventable.

The Middle Ear.

The middle ear is located at the inner end of the auditory meatus. It is an irregular, roundish, cavity, separated from the meatus by a thin translucent membrane called the tympanic or drum membrane. In the drum membrane is lodged one end of a very small bone called the malleus. The other end of the malleus is connected with another small bone (incus), and this with a third (stapes). This chain of three small bones (ossicles) stretches across the cavity of the middle ear. The inner end of the third small bone fits into a membranous opening which separates the middle ear from the inner ear (see Fig. 157).

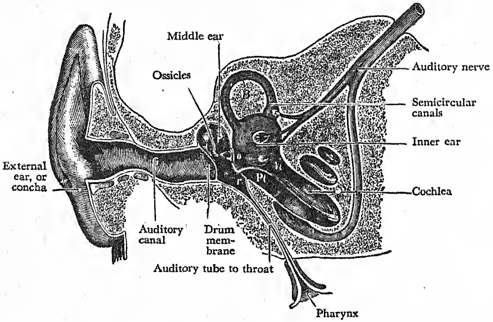


FIG. 157.—(From Stiles "Human Physiology." Courtesy of the W. B. Saunders Company Publishers.)

The function of the ossicles is to vibrate when sound waves strike the drum membrane from outside. Hearing would not follow the vibrations of the ossicles, however, if it were not for the fact that they communicate with the inner ear, where are located the cells that catch the vibrations and carry nerve impulses to the brain, where they are perceived as sound.

From the middle ear there leads a tube (Eustachian or auditory), which connects with the pharynx. This tube is about an inch and a half long, and its lining, like that of the middle ear, is continuous with the mucous membrane of the whole respiratory tract.

Behind the middle ear is located the mastoid portion of the temporal bone, in which are the mastoid cells. The mucous mem-

brane of the respiratory tract not only lines the middle ear, but even extends into these cells.

Impaired hearing results when any cause prevents sound waves from reaching the ossicles with full force, or when any cause keeps the ossicles motionless so that they do not vibrate.

Approaches to the Middle Ear.

It should be noted that the middle ear is approached from two directions: (a) from the exterior, by the external auditory canal; and (b) from the throat, by the Eustachian or auditory tube. Either of these two paths may become the route whereby infection reaches it. The drum membrane at the inner end of the external canal ordinarily effectively prevents the entrance of any foreign substance, including bacteria, into the middle ear from the exterior; but there is free communication between the throat and the middle ear through the auditory tube. Furthermore, the mucous lining of the nose and throat is continuous with that of the ear, and bacteria that thrive in the former locations are likely to spread by continuity through the short auditory tube. Most middle ear infections originate thus.

Swelling of the Auditory Tube.

The mucous membrane of the auditory tube is prone to swell during nose and throat infections. Because the tube is of small calibre, its swelling may close it entirely. This changes the atmospheric pressure within the cavity, and produces a sensation often described as "dullness" in the side of the head. There is also a sensation, when speaking, as if "talking into a barrel." Both these symptoms disappear when the swelling subsides; but often it does not subside at once, for the congestion is likely to extend to the middle ear.

Inflammation of the Middle Ear.

Simple congestion of the middle ear is a common occurrence. From the swollen mucous membrane, mucus is given off, which soon fills the small cavity, and causes pain. If the auditory tube is so swollen that the fluid cannot drain off in that direction, it may rupture the eardrum. Thereafter the pain ceases abruptly, and the drum membrane usually heals readily, unless infection sets in.

An abscess of the middle ear is similar to the condition just mentioned, but pus forms, instead of mucus. The symptoms are the same, although they may be more pronounced. The danger is, of course, greater, for bacteria may spread from the ear to the

mastoid cells behind the ear, and from there to the coverings of the brain or even to the brain itself. Complications are particularly likely to occur if there is delay in the discharge of the purulent exudate.

Ear abscesses may arise during a cold or an illness that includes nose or throat infection (e.g., scarlet fever). Obviously an earache, or any sign of trouble in the ears, should be taken seriously. If promptly treated, even a quite severe infection may be cured without leaving a perforated eardrum, chronic infection, or deafness.

Perforation of the Eardrum.

Occasionally the eardrum is ruptured by accident (as from a blow on the ear). But more often it ruptures spontaneously to release fluid from the middle ear, or must be ruptured for that purpose by a physician. In some cases the membrane heals, and in other cases the opening persists. Its healing is more likely when the fluid discharged was free of bacteria, or, if it contained bacteria, was removed surgically rather than spontaneously. A perforation may or may not interfere with hearing; usually it does so to some extent.

Since the drum membrane is a protection to the middle ear (against infection from the exterior, and to some extent against external cold), those whose eardrums are not intact should know of it, and should exert care accordingly. At least 25% of adults either have or have had perforated drums, and many of them did not suspect it until the ears were examined.

Auditory Canal.

Infection of the middle ear less often enters through the auditory canal than from the throat, except when the drum membrane is perforated. Occasionally, however, an intact drum membrane may be ruptured as a result of efforts to clean the external canal. The instrument used may actually reach to the drum and perforate it, or it may cause infection in the canal, with subsequent infection of the drum membrane and middle ear.

The external canal should need no attention, for it is usually self-cleaning. Cerumen normally dries as it moves outward and is shed in imperceptible flakes. Occasionally, especially in those with oily skin, the cerumen does not dry, and is not shed fast enough to keep the canal clean. In such cases, it may be removed by means of absorbent cotton wound around the end of a match. No other instrument should ever be used, or injury and infection of the canal, possibly a boil, are likely to occur. A boil in this location is ex-

tremely painful because the tissue is dense and lies close to the bone. Also, as mentioned, the infection may extend inward.

Frequently cerumen that is not shed and accumulates in the canal forms a plug that fills the canal from the eardrum outward for a short distance. It is thought that inept attempts at cleaning the ears may often be responsible for this condition. Care should be taken to insert the cotton-covered match through the center of the canal, not along the wall, so as not to push cerumen farther back. Impacted cerumen gives slight deafness, with sometimes slight pain, "noises," dizziness or nausea. If these symptoms are present, the ears should be examined. An accumulation of dried cerumen can be removed with safety only by a physician.

Extreme drying of the skin that lines the canal is inadvisable, for it may lead to a compensatory overproduction of cerumen. Therefore women should fill the opening of the canal with cotton when having the hair dried by heat.

Adenoids and the Ears.

The openings of the auditory tubes in the throat may be partly or completely blocked by adenoids. When no air is admitted to the middle ear through this tube, the small bones will not vibrate in response to sound. Deafness will be present to the degree that vibration is absent. Unless the condition has persisted so long that the joints between the bones have become immovable or swelling of the tube is chronic, hearing should be improved after removal of the obstructing adenoid growth.

Mastoiditis.

Aside from the danger of deafness as a result of disease of the middle ear, there is also the danger of extension of the infection to the mastoid cells just behind the ear. Since material as thick as pus does not drain well from these cells, and since they are separated by only a thin layer of bone from the brain, a mastoid infection is a serious matter, usually requiring operation for drainage. If performed early enough, it is usually successful and may not leave a conspicuous scar unless the infection was extensive.

Chronic Middle Ear Infection.

When healing of an acute ear abscess is delayed, complete healing may not occur, and chronic infection thereafter be present. Usually such infection is not active constantly, but is likely to flare up and to give discharge from time to time. Special precautions are needed to prevent this from happening. The individual so

afflicted must be under medical supervision, and he may hope for freedom from episodes of active infection if he uses due care.

Protection of the Middle Ear.

The prevention of middle ear infection and deafness consists chiefly of the prevention of nose and throat infections, and immediate attention to those that do arise. It also involves the clearing up, if possible, of any chronic ailments of the nose and throat. Those with chronic middle ear disease should be very careful not to catch a cold or any other infection of the respiratory tract, and if they do, to have medical treatment for it.

Certain precautions should be observed, especially during a cold, in order not to assist bacteria to enter the ears. (*a*) Blowing the nose is often responsible for actually forcing bacteria toward the ear. This is likely to happen if the mouth and one nostril are held tightly closed. A sensation may be felt in the ear at once, which may indicate that it has been filled with secretion. To rid the nose of secretions, the nose should be blown gently, with the mouth open and only one nostril closed at a time, and not too tightly. (*b*) Snuffing antiseptic solutions up the nose, or spraying or syringing the nose, may wash secretions containing bacteria into the auditory tube (and perhaps also into the openings of the sinuses). The use of nasal douches has undoubtedly caused much trouble that would otherwise not have occurred. They should be used only when advised by a physician, and strictly according to directions.

In everyday life the main precautions, besides preventing nasal infections, are against undue chilling of the head, which renders the middle ear more susceptible to infection. A strong draft blowing on the ear, even indoors while sitting still or lying in bed, may constitute a danger. Sitting still outdoors, especially while driving in a cold wind or rain, may also be hazardous, particularly for the individual who is susceptible to ear trouble. Chilling of the ears in women may be the result of going out into the cold or allowing a cool breeze to blow on the head after having the head overheated by hair dryers.

The normal ear is not usually harmed by swimming or by diving head first, if the water that enters the nose is quickly expelled before an inward breath is taken. Jumping into the water feet first is to be avoided. Those with chronic middle ear disease, or perforated drum membranes, or even with susceptible middle ears, should not indulge in water sports. The fallacy of expecting to protect the middle ear by plugging the external canal is apparent when

it is realized that there is another entrance to it from the throat, and one even more accessible than the canal.

The Inner Ear.

The inner ear is a very complex structure. One part of it is the cochlea for the reception of sound. It contains fluid which begins to vibrate when the ossicles in the middle ear are set in motion. Such vibrations are taken up first by certain cells of a specialized sort, and then by the nearby filaments of the auditory nerve.

The auditory nerve-endings are sensitive to sound vibrations only. Humans are able to appreciate sound vibrations from a rate of 25 per second to 25,000 per second, or even higher in the very young. Some animals can hear high-pitched sounds that the human ear can not. As age advances, the range of hearing in humans decreases.

Mere sound is produced by sound-waves following each other irregularly; musical sounds result from regular or rhythmic vibrations. Nearly all single sounds audible to humans can be assigned a musical pitch within the range of the seven and a half octaves of the piano.

Inner Ear and Nerve Deafness.

Deafness from defects in the inner ear and the auditory nerve may, like middle ear deafness, be due to infection, but usually not by the routes to and through the middle ear. The infections that most commonly involve these structures are syphilis, meningitis and scarlet fever.

Hereditary deafness is of the inner ear type. It is present at birth; because of the lack of hearing the child does not learn to talk and becomes a deaf-mute unless it has the benefit of special training.

Treatment of Deafness.

A person who notices that his hearing is beginning to fail should not accept deafness as inevitable until examinations have been made for its cause, and any treatment to improve it, or at least to prevent it from becoming worse, has been faithfully used. In some cases there is unfortunately little to be done by the time treatment is sought, although the chances might have been better at an earlier stage. In progressive cases, lip-reading should be learned before hearing is too much impaired. Even the slightly deaf will be greatly helped, socially and otherwise, by the visual reinforcement of their auditory impressions.

When deafness is due to disease of the middle ear, sounds will not be conducted through air, but will be conducted through the bones of the skull as usual. In such a case, they pass directly to the sound-receiving apparatus of the inner ear and are taken up by the auditory nerve. Devices to aid hearing utilize this principle. They are of use in middle ear deafness only, for in deafness due to defects in the inner ear or auditory nerve, the problem is not one of conduction of sound to the receptors but of inability of the receptors to receive it.

The Ear and Equilibrium.

Another portion of the inner ear, the vestibule, consists largely of the semi-circular canals, of which there are three. They are filled with fluid, which shifts with changes in the position of the head. The vestibular nerves receive and transmit to the nerve centers sensory impulses of position. These are reflexly acted upon so as to maintain equilibrium.

When the head moves, one of the semi-circular canals registers if the motion is a forward or a backward one; another, if the motion is from side to side on the vertical axis; and another, if the motion is lateral from vertical to horizontal. Other motions of the head affect each of the three to some extent.

Motion Sickness.

If the semi-circular canals are out of order, dizziness or vertigo may result. Some individuals seem to be more susceptible to a disturbed sense of equilibrium than others, and are subject to motion sickness. This term is used to include seasickness, car sickness and air sickness, all of which are due chiefly to the effect of motion upon the vestibular apparatus of equilibrium. Presumably the nervous system is unable to cope with the many conflicting impulses arising from the overacting and disturbed semi-circular canals, and reflex symptoms such as nausea arise.

Some individuals are barred from aviation on account of the way in which their semi-circular canals behave when the position is frequently changed. Tests of vestibular function are among the first that are done in choosing those suitable to become pilots.

To prevent some of the discomfort from motion sickness, it is often useful to prevent any unnecessary motion of the body by bracing it, including the head, against some rigid part of the moving structure. In some cases, the semi-circular canals seem to function better with the body in a horizontal position, or with the head bent forward; experimentation may show that one position is more favorable than another.

Because the muscles that move the eyes are involved in the function of maintaining equilibrium, those who are troubled with motion sickness often find that they are helped by closing the eyes, or by looking only at relatively stationary objects, to avoid the constant swing of the eyes in adjusting to the varying distances of objects being passed.

The nausea which is the essential symptom of motion sickness often may be prevented by wearing tight clothing or a bandage around the lower trunk, to steady the viscera. It is usually helpful to eat dry food such as crackers and cheese, but not to take liquids or to refuse all food. If the gastrointestinal tract is empty or full of fluid, it appears to be more susceptible to the effects of changing motion.

In enclosed poorly ventilated places, the stuffy air contributes to the illness, but is not so much responsible for it as is the unsteadiness of the body. The effect of unpleasant odors, bad enough in any circumstances, may greatly increase the nausea of motion sickness.

That this ailment is by no means a psychological one, and not the product of fear or suggestion or any other state of mind, is made evident by the fact that many individuals discover precisely what motion it is that affects them. For example, some are not made ill by the large motions of an ocean liner, but are by a row boat or a smaller coastwise steamer; by a car with one type of shock absorber, and not with another type; by a parlor car in which the position must be upright, and not by a sleeping car in which the position is recumbent.

Medication for motion sickness is of the sort either to reduce vestibular sensitivity or to allay spasm and decrease secretion of the digestive tract. Together with other advice which the physician may give, medication may make travel fairly comfortable.

Chapter 40

CLOTHING

Reasons for Choice of Clothing.

There are many reasons for clothing apart from that of health maintenance, and many factors other than hygienic ones that influence the choice of clothing. This has been so since clothing was first adopted by the human species. Whether it was first worn as adornment, or in response to a dawning sense of modesty, or for social or class distinction, or for comfort, anthropologists do not agree. Yet for whatever reasons clothing was first worn and continues to be worn, and whatever motives underlie the choice of clothing, it cannot be denied that coincidently the clothing put upon the body has its effect on the physical and the mental health of the wearer.

Five Health Considerations.

Clothing affects the physical health, either favorably or unfavorably, in five important ways, as follows: (*a*) through its effect on the temperature of the body; (*b*) through its mechanical effect (of pressure, etc.); (*c*) through its effect on cleanliness and soundness of the skin; (*d*) through its admission or exclusion of sunlight; and (*e*) through its effect upon mental health.

A. CLOTHING AND TEMPERATURE

In considering temperature regulation, the aim in choosing clothes should be to assist and not to hamper the efforts the body makes to adapt to varying temperature conditions. Enough clothing should be worn in cold weather to spare the body to some extent the task of producing heat, and a sufficiently small amount in hot weather to enable the body easily to cool itself. Comfort is an important guide if it is heeded, but it is not always comfort that dictates the choice of clothes, and the temperature preferences may be perverted.

Too Much Clothing.

Many people wear too much clothing, especially indoors in winter. Among the various unfavorable effects may be mentioned the following. (*a*) An excess of clothing leads to an elevation of sur-

face temperature, and, unless it is immediately compensated for, an elevation of body temperature. When too heavily clad, the body is affected in much the same way as when in bad air—i.e., by drowsiness, dullness of the wits, headache, and lack of a feeling of energy. In fact the excessive warmth about the body is responsible for the symptoms in both cases.

(*b*) Too great warmth from clothing leads to perspiration, which is in itself disagreeable, and is likely to lead to chilling.

(*c*) Those who habitually wear too much clothing become sensitive to temperature changes, and are uncomfortable too often on that account, as well as unsafe except in their accustomed warmth.

(*d*) Metabolism is reduced in those who are overclothed. The lack of the metabolic efforts that would be called into play to produce more heat, is reflected in the functioning of many organs (e.g., appetite and digestion are often impaired).

Clothing should be reduced to the minimum that secures comfort and that permits easy and satisfactory temperature regulation. Infants and the aged need plenty of clothing, but often even they are too much bundled up. The feeble also need more clothing than the healthy, but sometimes not as much as they think. Those whose rate of metabolism is somewhat above normal often need surprisingly little; whereas those whose rate is low may find it difficult to keep warm, whatever they wear.

In general, those who have trained themselves in adapting to various temperatures and are well-nourished, and who live in properly heated houses in the winter (i.e., 70° F.), will do well to wear summer clothing indoors the year around.

Men's Clothing.

Practically all men wear far too much clothing for comfort or health. A noted German hygienist made experiments to test the temperature and humidity inside the clothing of men and women. He found the temperature inside the ordinary clothing of men averaged 10° F. higher than inside women's, and the humidity often 50% higher. He stated "The average modern man spends most of his life, winter and summer, in the debilitating climate of the tropics. Only his face and hands are allowed to stick out into healthier surroundings. The average woman . . . lives in a climate like the cool, dry air of the Alps."

An English physiologist has suggested that the supremacy of men is doomed, and that women will inevitably supplant them in positions of leadership, unless men learn to wear less clothing.

Too Little Clothing.

The harm of too little clothing is that too much of the ingested energy-producing material must be used to maintain temperature, and too much cellular activity is spent merely in keeping warm. The underclad individual must eat more and exercise more in order to keep comfortable and well. If he does not eat and exercise more, he may be able to stand the discomfort of being cold, but his vitality and resistance to disease may be appreciably lowered. This is particularly true if the individual has little fat under the skin, which in itself provides a sort of protective covering against the effects of cold.

Materials and Heat Conduction.

The amount of assistance or interference given the heat-regulating system depends more upon the materials of which clothing is made than upon the number of garments worn. All materials are classified according to their power to conduct heat away from the body and their power to absorb moisture. It will be noted that no materials actually produce heat for the body. They can merely retain it near the body, if they are poor heat conductors.

Materials used for clothing are from the vegetable kingdom—cotton, linen, rayon; and from the animal kingdom—wool, silk, fur. Generally speaking, those from the animal kingdom are warmer than those from the vegetable kingdom because they are poorer conductors of heat.

Weave.

Because dry air is a poor conductor of heat, any material so woven as to enmesh a good deal of air feels warmer than the same material closely woven. Although wool is intrinsically a poor conductor of heat (hence warm) it is additionally so because its fibers are rough and do not lie close together. It becomes still warmer when it is loosely woven. Cotton may be woven so as to contain air in its meshes (e.g., cotton blankets, which seem warmer than sheets containing the same kind and amount of material). Silk, too, may be a cool or a warm material, according to its weave. However, if the spaces between fibers are wide, air may not be enmeshed but may pass through, an advantage in hot weather.

Absorption and Evaporation.

Materials vary in the degree to which their fibres will take up moisture, and the rate at which the moisture evaporates from them. Evaporation is in inverse proportion to absorption.

Materials that absorb much and give it off slowly feel warmer than others. Wool feels warm not only because it is a poor conductor of heat, but because it keeps the body dry by taking up its moisture and giving it off slowly. Other materials feel cooler because evaporation from them is rapid.

To test the rate of evaporation, and the consequent cooling of the skin, a piece of material may be moistened and placed upon the back of the hand in the breeze of an electric fan. When the various materials are tested thus, it will be found that wool dries more slowly than any of the other materials, and that the hand is not so much cooled under it. Obviously, woolen outer garments are a good protection against chilling, and silk, cotton or linen are more appropriate for hot weather and indoor wear.

Ordinarily there is less danger of chilling from prolonged contact with slowly evaporating materials than short contact with rapidly evaporating ones. For example, it would probably be less dangerous to sit an hour in a wet woolen coat and wet woolen stockings than five minutes in wet linen, cotton or silk clothing.

Because wool does hold so much moisture, it is not a suitable material for garments worn next the skin, unless great care is used to keep them scrupulously clean. Otherwise they soon become odorous, and because of the bacterial growth in them may injure the skin.

Thickness.

Other things being equal, the thicker a material the warmer; but other things are not always equal. A thin material that is a poor heat conductor, and that absorbs freely and evaporates slowly, and is woven so as to enmesh air, will be warmer than a thick material without these qualities. (E.g., a thick bedpuff filled with cotton is not so warm as a thinner woolen blanket.)

Furthermore, two layers of any material are warmer than one layer of the same material, even though the aggregate amount of the material is the same. The reason for this is that a certain amount of air will be held between the layers, and act as a non-conductor of heat away from the body.

Impervious Materials.

The impervious materials are commonly worn to keep out moisture (rubber and oiled materials) or cold and wind (leather and fur). They all form a definite barrier between the body and its environment. The tendency is for them to conserve body heat by allowing little cold to reach the body and little heat to escape from it.

Although valuable for the purposes for which they are worn, impervious materials create certain difficulties owing to the fact that they cannot absorb perspiration and also interfere with its being evaporated at the usual rate. Under impervious garments except in the coldest weather when activity is little, a considerable amount of perspiration inevitably collects upon the skin. Unless an absorbent material is worn under the impervious one, cold air entering at the neck and wrists and from below is likely to give one a cold and "clammy" feeling which is an indication of too rapid evaporation. Therefore wool, the most absorbent material, should be worn under them as a rule. Exceptions would occur in the case of fur coats as worn by women in winter, under circumstances when little perspiration will occur.

Fur owes its unusual warmth both to its being impervious in respect to the pelt and air-containing in respect to the hair. Fur coats should always be kept fastened outdoors and removed indoors. In removing any impervious garments care should be taken not to allow the accumulated moisture to evaporate too rapidly.

Color.

Dark colors absorb more heat rays of the sun, but light colors absorb more of the health-giving ultraviolet rays. The former fact may be proved by noting the greater rapidity with which snow melts under a dark than under a light piece of cloth. The latter can be demonstrated by placing photographic sensitized paper under a material and noting the greater degree of "printing" under light colors. The custom of wearing dark colors in winter and light ones in summer is therefore well founded.

Variations in Clothing.

Until the present century it was the custom to change the amount and kind of clothing, underwear and all, twice a year. No such abrupt seasonal changes are now made. Instead clothing is adapted to the weather from day to day, even from hour to hour.

The old idea persists, however, in regard to fur coats. Many believe that a fur coat must be worn every day, regardless of the weather, after it is first put on in the early winter. This is a mistake. Perhaps the greatest danger of chilling comes about through wearing fur coats day in and day out. Those who do so are certain to become overheated at times, and will have to use great care not to evaporate perspiration too rapidly at such times.

The chief variation in clothing that may in some circumstances cause trouble is that from day dress to evening dress in the case of

women who wear woolen dresses or sweaters during the day. The contrast may be too great, especially if precautions are not taken to avoid draughts, to which the back of the neck and shoulders are particularly sensitive.

B. MECHANICAL EFFECTS OF CLOTHING

Anything that is worn on the body is capable of affecting it mechanically, either by pressure, traction, weight or friction. It is important to see that clothing does not (*a*) change the normal shape of the body; (*b*) weigh it down; (*c*) displace organs; (*d*) interfere with normal functions of organs (e.g., breathing); (*e*) make correct posture difficult; (*f*) limit activity either by constriction or by its weight; (*g*) cause congestion of circulation; (*h*) harm soft tissues and the skin by rubbing or pressure.

Fig. 158.—Gymnasium suits at Vassar College in 1860. (From Leonard's "History of Physical Education." Courtesy of Lea & Febiger, Publishers.)

Girdles.

Corsets as formerly worn were injurious in most of the respects mentioned. More recently no corsets were worn—which was a very healthful practice. At present there is some danger that women will again fall victims to the very articles of clothing that they had so wisely discarded. However, girdles may be such as to do no harm at all. As at present worn, the chief dangers are (*a*) downward pressure on the abdominal organs; and (*b*) constriction of the waist and lower chest.

To guard against these dangers every corset or girdle should be properly fitted to the individual who is to wear it. Otherwise it is likely not to stay in place unless it is too tight or is anchored by garters.

The best sort of girdle fits closely around the hips, and hardly extends above the waist. The pressure exerted on the abdominal wall is horizontal not downward, and serves only to hold the organs in their proper position. It leaves the upper abdomen and chest entirely free for breathing. Corselettes, that are fitted throughout, are not correct unless they are fitted when the lungs are expanded

and definitely loose when the lungs are contracted. The garters should always be adjusted more tightly in back than in front, so as not to increase the lumbar curve by tipping the pelvic bones forward.

Whether a girdle or corset is worn or not, attention should still be given to the abdominal muscles and to the upright carriage of the back. No corset of itself can make the figure good.

Brassieres.

Although their confining effect may be aesthetically and physiologically desirable for those who are overweight, brassieres may be harmful if worn so tight as to prevent full expansion of the lungs, or to injure the particularly susceptible breast tissue. In adjusting them, the breasts should not be pulled downward, so that they become pendulous, but upward or horizontally in the direction of the chest wall.

Belts, Bands and Garters.

Any narrow constriction around the body may be injurious. When no girdle is worn, elastic bands in women's underwear should not be at the waist line but just at the top of the hip bones. Men's belts, like women's, should rest on the hip bones.

Women's stockings should be supported by a garter belt also adjusted at the hip level. Garters around the legs are likely to cause constriction of veins and predispose to varicose veins if worn either just above or just below the knees. Where worn by men, around the calf of the leg, they are less constricting because the pressure comes chiefly on the muscles and less directly upon veins. However even in that location the elastic should be wide.

Weight.

While considering materials from the point of view of warmth, it should be recalled that weight and warmth are not synonymous. Outdoor garments are often objectionably heavy. Bulk for bulk, the lightest materials are wool or camel's hair, but if either of these materials contains any cotton, their weight is greatly increased, and their warmth decreased. Women's coats for winter are often interlined with cotton rather than with lamb's wool, and on this account are unnecessarily burdensome. The difficulty is increased if such coats are not properly fitted. They should fit so that the weight is evenly distributed over the shoulders, with no tendency to pull the shoulders and spine forward.

C. CLEANLINESS AND CLOTHING

If it is itself clean, clothing helps to keep the skin clean. Contact of the skin with many sorts of dirt is prevented by the wearing of garments that cover most of the body, and that may be often exchanged for clean ones. If the whole body were as much exposed as the face and hands, the task of keeping free from infection would be greatly increased. It cannot be estimated how much bacterial infection or how much skin irritation is due to soiled clothing, but it is probable that it is in proportion to the offensiveness of such garments to the visual and the olfactory senses.

This subject would scarcely need to be mentioned if it were not for the fact that athletic clothing is often allowed to remain soiled for weeks at a time, even by those whose esthetic and sanitary sense would prohibit such conditions in their regular clothing.

Any clothing that comes into contact with the skin needs cleansing frequently. In fact, after any garment has become moist from perspiration it should not be worn again until it has been cleaned. Moist clothing is a good culture medium for bacteria. The organic material remaining in clothing that has been worn next the skin may support bacterial life for some time. Drying and "airing" are not substitutes for cleaning.

The usual laundry procedures render clothing virtually free of bacteria. Clothing that cannot be laundered can be made bacteriologically clean by dry cleaning methods using gasoline, or by steam cleaning.

Exposure to outdoor sunlight is also a satisfactory means of disinfecting the surface of clothing, but ultraviolet rays are not penetrating.

D. SUNLIGHT AND CLOTHING

The material of clothing, its weave and its thickness, as well as its color and the amount of the body it covers, all modify the amount of sunlight that reaches the body, and thereby affect the health markedly. For the maximum amount of irradiation, the material should be of vegetable source, open in weave, thin, light in color, and abbreviated in cut. (See Chapter 33.)

E. CLOTHING AND THE STATE OF MIND

The psychological aspects of clothing are as important to mental health as the physiological ones are to bodily health. There are

emotional reasons for the choice of clothing, and, in turn, the clothing worn influences to some degree the emotional life.

Although not consciously present in the mind, there is probably always in the background, in choosing clothes, a desire that the clothes shall represent the ego. Those in whom this desire is conscious are usually the ones who are most successful in declaring their own personality thus. They may, however, choose their clothes as an actor does the costumes to be worn in playing a part, to represent what they wish to seem rather than what they really are.

Nevertheless, the entirely unconscious choice of clothing may as definitely represent the character. For example, those who unconsciously feel themselves inferior often strive equally unconsciously by their clothing, that fairly shouts for recognition, to attract the attention not otherwise possible. The clothing may be no more blatant, however, than the individual's manners.

Inferiority feelings may lead others into the slavish following of style, and an unwillingness to appear without expensive clothing that is in every detail exactly what "they" wear on given occasions. Such lack of self-confidence will usually show itself in other ways and be generally hampering, unless it is recognized and overcome.

The opposite state of mind, complete disregard of dress, does not always, however, indicate an individual of great self-reliance. It may mean merely a defiance of social demands, that will also be found exhibited in other ways, and be responsible also for other, more serious, lack of conformity.

Since it is usually impossible to determine what lies behind a choice of clothes, great care should be used in concluding that the character is typified by the apparel. For one reason or another, clothing may not be at all self-expressive. It is not even certain, for example, that a disorderly mind will be found in disorderly clothing, or that a vain person will be found in ornate clothing, or one interested in sex in so-called "suggestive" clothing. The reasons dominating the choice of clothes may be quite other than they appear. It is worth bearing in mind, however, that society commonly does so judge an individual by his clothing.

The well-adapted individual does not scoff at clothing, but, recognizing its psychological effect on himself and others, gives it enough but not undue attention—as a result, finding some support for his ego in being clad in a manner representative of himself and his role in life; satisfying his herd instinct by being comfortably in conformity with custom; obtaining some esthetic pleasure for himself; and, by making his appearance as agreeable as possible, at least avoiding giving offense to others.

Chapter 41

CLEANLINESS

Cleanliness is a matter of esthetic interest and of health interest. From the former point of view its values are so obvious that they need not be mentioned. In fact suspicion would arise regarding the normality of a person who, after childhood, lacked appreciation of cleanliness as a foundation of self-respect and social acceptability. From the health point of view the value of cleanliness lies in the realm of bacteriology. This value, too, is quite generally appreciated by the average educated adult.

The only questions that need be considered in this chapter concern, first, the effectiveness of the various methods in common use for attaining both esthetic and bacteriological cleanliness, and second, the results that any such cleansing procedures might have upon the skin itself or upon physiological functions.

A. BATHING

Bacteriological Aspects.

Any bath taken for esthetic purposes is likely also to meet the needs for bacteriological cleanliness, since the generous use of soap and warm water is essential for either purpose.

The effect of soap and water is, first, a *mechanical* one—that is, it washes away a good many bacteria from the surface of the body, along with any accumulation of sweat, sebum and dead epithelial cells, and any other dirt from the exterior. Second, soap has a definitely *antiseptic* effect. It kills some bacteria and lowers the vitality of others. Against some kinds of organisms (e.g., the streptococcus and the gonococcus) soap has been shown to be more germicidal, even, than carbolic acid. Its effectiveness increases with the amount used, and is greater in warm water than in cold. There is little difference in the antiseptic properties of different kinds of soaps. Ordinary white bath soap seems to be as effective as soaps containing disinfectants.

The cleanliness of the skin in itself is of bactericidal value. It has been shown that the skin destroys bacteria placed upon it, provided it is clean and intact. In certain experiments 90–95% of

the bacteria in a broth culture placed on clean skin were killed in 10 minutes, but survived many hours if the skin was dirty or greasy.

Not to offset the improvement in bacteriological conditions on the skin, all utensils used for bathing (bath cloths, brushes, towels, etc.) must be scrupulously clean—that is, thoroughly washed and dried since the previous use of them.

Physiological Effects of Bathing.

Whenever water at any other temperature than that of the skin is applied to it, it produces a direct local effect—either heating or cooling—and secondary effects dependent upon what happens in the body to adjust to temperature changes at the exterior. Both primary and secondary effects vary with the temperature of the water, the duration of the bath, and the state of the body at the time it is taken. Certain kinds of baths may produce rather marked effect upon general metabolism, the circulation, the nervous system, and temperature regulation; thereby any function of the body may be affected. Balneotherapy (treatment by baths) is based upon the possibility of making changes in function in these various ways. Numerous sorts of baths are of specific value in specific conditions of ill-health. In every-day life, some of these specific effect of baths are worth consideration. The main difference to be considered is the matter of temperature.

The *hot* bath is one appreciably above body temperature (100° F. or more). The *warm* bath is very near to body temperature (96–100° F.), but feels warm to the skin, which is usually not far from 93° F. under average environmental conditions and when the body has been at rest. The *tepid* bath is approximately at skin temperature. The *cold* bath is any bath that feels cold to the bather, although the term usually has reference to a temperature well below that of the skin. Tap water averages about 68° F.

The Tepid Bath.

The nearer to *skin* temperature, the less pronounced will be the changes a bath makes in body temperature and metabolism. Such a bath is said to be neutral in its effects. A long tepid bath has a marked sedative effect upon the nerves.

The Warm Bath.

The bath at about *body* temperature is the most satisfactory for cleansing purposes and has a number of other specific values. It is the most satisfactory sort of bath to be taken daily. It may safely be

taken by those in any state of health. It need not be omitted during menstruation.

There are virtually only two precautions regarding the warm bath. Since it draws blood to the skin, care must be taken not to become chilled after it, nor to interfere with digestion by taking it immediately after a meal, at which time it might deprive the stomach of some of its needed blood supply.

In several special circumstances, warm baths are particularly valuable. First, warmth at the exterior is of assistance in overcoming the effects of chilling, which often involves an actual lowering of body temperature. To produce a rise of body temperature, the bath should feel appreciably warm, and should be sufficiently prolonged. After leaving it, the body should be quickly dried, and then covered, so that it will retain as much heat as possible. The slightest exposure to cold after such a bath may be followed by chilling. Therefore it is appropriate to go to bed after it. The reaction when warmly covered up in bed may be sweating. This indicates merely that the body has been warmed and is eliminating some of its excess heat, but the beneficial effect of a warm bath is not necessarily in proportion to the sweating.

Second, the warm bath has a relaxing effect upon the muscles after fatiguing physical exertion. It tends to prevent soreness and stiffness and to relieve such conditions if they have already appeared. A brisk rubdown is also helpful at such times. A cold shower in conclusion is recommended in the case of those who are going out of doors thereafter.

Third, a bath only moderately warm has somewhat the same sedative effect as the tepid bath. It is the sort of bath to be taken after a tiring day, to freshen up for the evening.

In general, warm baths taken at any time except bedtime should be either not very warm or followed by a cold bath.

The Cold Bath.

The effect of a cold bath would be cooling were it not for the fact that the body may compensate for it by increased heat production. In the majority of young vigorous adults the total effect of a short cold bath is warming, not cooling. The first effect is that of driving the blood from the surface to the interior, but immediately the muscles contract and the rate of metabolism increases. If the cold bath is brief and is followed by brisk rubbing, the skin soon becomes warm and the whole body feels "in a glow."

Provided the reaction occurs as described, a cold bath has a generally stimulating and beneficial effect. However, if a cold bath appears to be too much of a shock, and leaves one shivery and cold, it is not beneficial, and may be seriously harmful. Many of those who cannot react well to a cold shower taken by itself can do so to a cold one following a warm one. The ultimate effect is the same. Few can react properly to a cold tub or sponge bath.

FIG. 159.—"The Shower Bath." (Daumier.) (Courtesy of Menley, James Company.)

The Hot Bath.

Whereas the extreme changes made in response to the cold bath are stimulating and beneficial to many people, the extreme changes associated with very hot baths are depressing and usually harmful. A bath should never be so hot that one must use caution in easing one's self into it.

The immediate effect of drawing a large quantity of blood to the skin may be fainting or disturbance of heart action. The secondary effect is relaxation of muscles and lowering of metabolism. To take a daily steaming hot bath is to run the risk of impaired vitality. It should be noted that the hot bath, because of its lowering of metabolism, is not the type of bath to be taken by those who wish to reduce their weight. The weight lost in perspiration is immediately regained.

The term hot bath is often used somewhat loosely to describe any bath over body temperature. It is preferable to distinguish between warm and hot, since their physiological effects may be quite differ-

ent, and because the one is nearly always entirely safe and the other nearly always unsafe, or at least unsuitable.

Turkish baths and other sorts of special baths that use extremes of temperature should not be taken unadvisedly.

Swimming Pools.

Swimming pools are, of course, common bath tubs, and they are safe or not, according as the water is disinfected and the behavior of those who use it is hygienic. Chlorine is the most common disinfectant used in pools. This may have a somewhat irritating effect on the mucous membranes, but in the percentage usually used does not seriously injure them. No means of disinfection of water keeps it clean unless the bathers carefully avoid contaminating it in anyway. It is customary to require of bathers in pools a given technique of preparation for its use, and to exclude all those having any infection.

B. THE COMPLEXION

Types of Skin.

By inheritance the quality of the skin on the face differs in different individuals. It may be thick or thin, oily or dry, of coarse texture or fine, with large sebaceous ducts or small, dark in color or light, hairy or comparatively hairless. In general, the first named of each of these qualities tend to be present together, although the skin may have any of these qualities in any degree or combination.

A poor complexion usually reflects bodily disorder of some sort, or poor care of the complexion itself. Many defects of the complexion are manifestations of faulty nutrition, and probably an equal number are due to lack of cleanliness. The major disorder of the complexion is the disease acne.

Acne.

A disorder of the sebaceous glands known as acne is especially common in the 'teens and twenties. The lesions—pimples, "blackheads," and "whiteheads"—occur chiefly on the face and upper part of the chest. They consist of sebaceous ducts plugged with sebum and dirt, with the resulting inflammation and infection.

The causes of acne appear to be both local and general; infection is always present locally, but general conditions may predispose to it. Nearly every aspect of ill health has been mentioned as possibly contributing to the skin's susceptibility to it.

The methods that are most often successful in overcoming a tendency to acne include, first and foremost, extreme cleanliness of the skin. This means the avoidance of all sorts of bacterial contamination of the skin, as by the hands; the avoidance of any and all cosmetics; and very frequent and very thorough washing.

Second, the diet should be made as nearly correct as possible. Some authorities believe acne to be due to an excess of carbohydrate, especially to sugar, in the diet; others, an excess of fat. Still others believe it to be a manifestation of deficiency of vitamins, especially of vitamin A, or of minerals. Third, the individual should note whether a new crop of pimples follows the taking of any special article of diet. In many, chocolate appears to have a particularly unfavorable effect. Fourth, intestinal elimination should be regular, for it appears that in the susceptible an attack of constipation may be followed by an eruption. Fifth, the skin should be exposed to direct sunlight, with care, however, not to become sunburned. Sixth, in all respects the health should be brought to as high a level as possible.

In pronounced cases of acne or in even mild cases that persist in spite of good health and good habits, medical service should be obtained. Skin specialists have at their disposal many varieties of treatment to meet individual needs. Nearly all cases of acne can be either cured or greatly improved.

No attempt should be made to open any of the lesions of acne except pimples that are red with a small white point (pus) at the top. These may be opened, after wiping with alcohol, by puncturing the extreme top with a needle sterilized in alcohol or a flame, so as to allow the pus to be wiped away with cotton dipped in alcohol. The pimple should not be squeezed, or its contents wiped over adjoining skin, lest other pimples appear nearby. There is also the danger, in any infection of the face, that it may spread to veins of the brain.

Unnecessary Soiling.

It is inevitable that the face should become soiled by atmospheric dirt, but it is not this visible dirt that creates the chief problem in keeping the skin clean. The sort of dirt that is most injurious to the complexion is usually put on it by quite unnecessary touching it with the hands, either bare or in gloves, and by contact with soiled objects such as a powder puff after it has been used once, or a handkerchief after it has been in the pocket or handbag taking up dirt, or a scarf or coat collar worn all winter without cleansing, or a face

cloth or towel not washed and dried since previous use. All such unsanitary contacts greatly increase the hazards of skin infection, particularly in those whose sebaceous ducts are large. In fact even the most thorough and prompt cleansing may not suffice to remove dirt and bacteria that have already entered the duct openings.

Cleansing Methods.

For the majority, an abundance of warm soapy water is needed to remove *visible* dirt, and especially to remove and destroy *bacteria.* No cleansing preparation, greasy or alcoholic, will serve the purpose, nor will water without soap.

The temperature of the water used to wash the face is to be determined according to the quality of the skin and its reactions. In general, those with thick skin stand extremes of temperature better than those with thin skin. If the skin becomes decidedly reddened after using very hot or very cold water, more moderate temperatures should usually be used. The more sensitive the skin, the nearer the water should be to the temperature of the skin itself. In some cases, extremes of temperature unduly stimulate the production of sebum in an oily skin. Running water is preferable to water in a bowl, if the faucets permit the flow of water at the correct temperature.

The freshly washed hands are usually the most satisfactory means of washing the face. Face cloths and complexion brushes and the like may be too irritating, or the source of additional infection. However, it appears that in the case of men, shaving brushes of soft texture, kept clean, are an aid rather than a hindrance to complete cleansing.

Thorough rinsing is important, to remove all the dirt and soap. Soap left on the skin may irritate it and cause it to look shiny. It may even arouse increased production of sebum in those with oily skin, or too greatly dry the dry skin. After rinsing has been accomplished, the hands will detect no trace of slipperiness, but instead will encounter slight resistance.

Drying should be by means of blotting or patting the face with an absolutely clean soft towel, or a disposable tissue. The face should be completely dried before going out of doors, or chapping or roughening may result.

The frequency with which the face requires washing depends on the skin itself and the amount of dirt to which it is exposed. Those with rather fine dry skin, living in a clean atmosphere, may succeed in keeping the face clean with only one soap and water washing a

day, at bedtime. However, the majority will require soap and water from two to several times a day—the latter in the case of those with oily skin and living in a smoky city.

Cosmetics.

It appears that few cosmetics made by reputable manufacturers contain chemicals harmful to the normal skin. When trouble arises from the use of cosmetics it is usually due to individual susceptibility, or to the method of application.

Whatever cosmetics are used they should be applied on the surface and not rubbed into the duct openings. Usually a foundation cream serves as a protection. Three invariable rules are: first, to apply cosmetics to the face only when it is clean; second, to apply them only with clean applicators; and, third, to remove them completely at night.

Powder is of two varieties: that from vegetable sources (chiefly rice powder, the basis of most so-called face powders); and that from mineral sources (talcum powder, the basis of bath powder, shaving powder and baby powder). The starch grains in vegetable powders have the property of taking up moisture, and swelling. Obviously, if such swelling takes place in sebaceous ducts, it is likely to cause them to become plugged—a special danger in the case of those with large duct openings.

Cold Cream.

The use of cold cream for cleansing the face is not advised except as a preliminary to soap and water. It has been said that Madame Patti never washed her face in water. The same has been said of other beauties, but there is room for doubt of the truth of the statements. Either the statements are false, or the individuals always had very dirty faces. In the case of those with thick skin and large pores, it would be likely to cause trouble sooner or later and in the meantime to leave the face looking soiled. Only those with thin fine dry skin are ever safe in limiting the use of soap and water.

Cold cream is useful as a lubricant of the skin, provided nature's cold cream, sebum, is not produced in sufficient amount to overcome the necessarily frequent washing. Its use at night is highly desirable for the dry skin but not for the oily one. It is also sometimes injurious to the skin subject to congestion and flushing.

The skin is not nourished through its surface, but from the blood vessels beneath it. No cold cream is a "skin food." In fact any pure cold cream is much the same as any other.

"After-shaving" lotions and liquid creams often contain glycerine. By abstracting fluid from the skin they may, in some cases, leave it more susceptible to chapping and drying, although for the time being they appear to have a softening effect.

Beauty Fads and Fakes.

The public, especially the feminine public, spends millions of dollars yearly for preparations or treatment for the complexion—an amount aggregating nearly as much as the total spent for all medical purposes. Unfortunately a great deal of this money is spent for preparations that are worthless, or too expensive, and perhaps harmful.

Physicians who specialize in the care of the skin (dermatologists) have made a special study of the skin in health and disease. It would seem logical to entrust any problems concerning the skin to them. People who have tried one thing after another for their skin defects and have not improved often do not realize how readily scientific treatment might have corrected the defect.

C. THE HANDS

Whatever is of importance in cleansing the rest of the body is, from the bacteriological point of view, infinitely more important in respect to the hands. A good deal of dirt on the hands is "clean dirt" —that is, merely colored material. "Dirty dirt" is that which is contaminated by pathogenic bacteria, derived from human excretions and secretions and from contact of the hands with contaminated objects.

That the hands tend to carry large numbers of bacteria may be proved by drawing the hands across a culture medium, a laboratory substance on which bacteria grow readily. After a time, at a favorable temperature, colonies of twenty or more different kinds of bacteria will usually appear even from hands that look perfectly clean.

Sanitary Requirements.

Even to approach the standard of clean hands, it is important first, to avoid any unnecessary contamination of them; and, second, to wash them thoroughly enough and often enough to keep the number of bacteria at a minimum.

As for the method of washing the hands, all laymen should have an opportunity to observe the "surgical scrub" used by surgeons in preparation for an operation. With a sterile scrub brush, as stiff as

possible, and a large amount of soap and water, the surgeon goes methodically over ever square millimeter of skin on each hand, and into every crevice and wrinkle. The performance is interrupted occasionally for the use of an orange stick around the nails and under their free margins. Such hand washing on the part of the general public would unquestionably be of great profit as a measure of personal sanitation.

There is a third sanitary requirement for the hands. Accepting the fact that hands are not, ever, quite clean, they should not be used in such a way as to infect susceptible parts of the body. Rubbing the eyes, scratching the lids, picking the skin, putting the fingers to the mouth and the nose, are dangerous habits. Somebody has said that if saliva were blue, one's hands would be always blue because of the frequency with which they are unconsciously put to the mouth or lips. Children are of course the worst offenders in this respect, but many adults continue the habit.

Less directly, bacteria from the hands may be taken to the mouth on food. Before eating, a final effort should be made to prepare the hands for whatever contact with food cannot be avoided.

Rough Hands.

The skin of the hands in most people becomes rather tough and durable, and will stand hard use. When it becomes irritated, it is most commonly because of too strong soap, especially soap not intended for the hands and not completely rinsed away. In winter, chapping of the hands is due almost entirely to incomplete drying, especially just before going out of doors. The use of cold cream at night, instead of glycerine-containing lotions by day, may give better results in keeping the hands in condition.

D. THE NAILS

The structure of the nail is shown in Fig. 160. It will be noted that the nail grows from the bed of skin beneath it and from the curved fold of skin (cuticle) in which its base is imbedded. Dirt catches readily at the cuticle margins, in the folds at the sides of the nails, and between the tip of the nail and the finger-tip, in which areas the skin is thin and does not possess the same bactericidal power as the skin elsewhere on the body. Special problems are therefore involved in preventing infection around the nails.

To keep the nails in order, the first essential is that the cuticle be kept intact. If not given daily attention the cuticle is likely to adhere to the nail and grow out with it, and consequently to become torn,

causing a "hang-nail." Infection is likely to follow, especially if the hang-nail is pulled off, rather than cut. A break in the cuticle is also likely to result if rough methods are used to keep it pushed back.

The most successful method of keeping the cuticle intact is that of pushing it back gently around the entire curve of the nail after every washing of the hands. At that time, the cuticle is softened and responds to gentle pressure. The towel used for drying the hands will usually suffice, or an orange stick may be used, but nothing of metal. Surgeons who keep their hands in order in this way do not require cutting of the cuticle nor chemical cuticle removers.

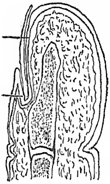


FIG. 160.—Cross section of the end of the finger showing the root of the nail.

Difficulties sometimes arise at the corners where the nail emerges from the cuticle. The nails should not be filed below the point of attachment to the bed. In this area, the motion of the file should be from the corner toward the center of the nail.

In applying liquid polish, care should be taken not to let it touch the cuticle or it will hold the cuticle against the nail and prevent its being pushed back. To keep the nails clean under their tips, a satisfactory procedure is again that used by the surgeon—a stiff nail brush, and an orange stick used while the hands are wet.

The necessary amount of hand washing has a tendency to dry the nails and the cuticle to some extent. This may be counteracted by rubbing a little ointment or cold cream on them at night.

With daily care as outlined, further care will hardly be necessary; to need a weekly manicure is usually an admission that the nails have been neglected for a week. Furthermore, in relying upon a commercial manicurist one unnecessarily increases the chance of taking up germs from other people's hands, or from objects used in common with others.

E. THE HAIR

Cleanliness of the hair and the scalp requires, first, daily brushing; and, second, regular washing.

Brushing.

Since the hair is nearly as much exposed to dirt as the face, theoretically it might be supposed that it needed washing as often. It does not, because of the fact that hairs are composed of a horny

substance that sheds dirt rather readily upon brushing, provided it is not too oily, and that the scalp is more or less protected from outside dirt by the hair lying over it. The need for washing arises chiefly as a result of accumulation of secretions from the scalp itself and of dead epithelial cells. However, daily brushing keeps the normal scalp fairly free of such accumultions for a varying length of time.

The only brushing that is at all useful is that done by a stiff brush, with bristles that reach through the hair to the scalp. Such a brush is expensive, but it is virtually a sanitary necessity for all but those with sparse hair.

In addition to its cleansing effect, brushing also serves to stimulate the circulation of blood in the scalp, and therefore to favor a healthy condition in which the sebaceous glands secrete neither too much nor too little. The stimulating effect appears to be increased by brushing the hair in the opposite directions from which it usually lies.

Shampooing.

The hair should be washed as often as is necessary, according to the rate at which secretions and dirt accumulate. It is thought that if the hair be brushed daily, the need for washing will not recur oftener than every two weeks in winter and every week in summer. There is no objection to washing it more frequently—even daily— if time is taken to do it properly.

Five rules for shampooing are: (*a*) use plenty of water, neither too hot nor too cold; (*b*) use plenty of soap that lathers well; (*c*) wash the scalp itself as thoroughly as the hair, rubbing it with the finger tips; (*d*) rinse the hair thoroughly, at least twice, until it squeaks when the hands are rubbed over it (if it still feels smooth, it needs more rinsing); (*e*) dry the scalp and the hair thoroughly, neither too rapidly nor too slowly.

Towels may be used throughout the drying process; or, after the excess moisture is removed, the process may be completed by exposure to sunlight and a breeze, or to moderate artificial heat. The hair should, of course, be completely dried before one goes outdoors in cool weather, for any but warm breezes may cause chilling of the wet scalp.

For dry hair, olive oil may be applied to the scalp the night before the shampoo. Part of the benefit of this procedure is that it requires more soap and water to remove the oil, and thereby more dirt will be removed, for which reason it is useful for any sort of hair.

Falling Hair.

The hair is perpetually falling out and growing anew. Because some hairs fall out, it is not to be concluded that the hair is necessarily growing thinner, for an equal number of new hairs may be taking the place of the old ones. The exchange of old hair for new takes place more rapidly in some than in others. There is also a difference in the rate of growth. The average rate is about a quarter to a half inch a month.

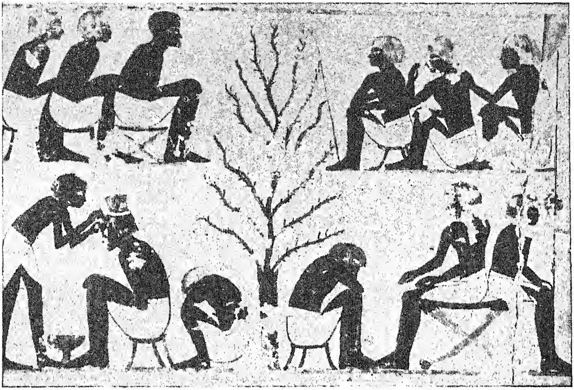


FIG. 161.—An Assyrian beauty parlor. The Assyrian barber is at work. His male clientele is shown on the upper left, his female customers on the upper right. The scene on the lower right depicts a pedicure, while the barber, on the lower left, rubs the customer's eyebrows off with a pumice stone. The vase at the barber's feet contains lukewarm oil for softening the hair. (Courtesy of Menley, James Company.)

In numerous unhealthy conditions of the scalp, hairs may fall out but not be replaced. When due to infection this may occur in limited areas. Ultimate regrowth depends upon whether the roots have retained their vitality.

The male sex is susceptible to baldness, a trait which is apparently hereditary and sex-linked (i.e., appears only in one sex, in this case the male). Nothing whatever can be done to prevent it and little to check its progress. New hair cannot be regrown on areas denuded by this type of baldness. However, males are also subject to thinning of the hair from other causes and should not accept bald-

ness as inevitable until they have consulted a dermatologist regarding the diagnosis and possibilities of treatment.

Diffuse thinning of the hair is often, but not always, associated with dandruff.

Dandruff.

Dandruff is a communicable disease of the sebaceous glands of the scalp, which is thought to be communicable through articles (brushes, combs, hats) used in common with the infected. It occurs in two forms: in one form an excess of sebum collects on the scalp as a greasy deposit; and in the other, as layers of dry scales which cause itching and are shed abundantly. The latter type is more common after childhood. No amateur methods of treating dandruff will do more than to remove for the time being either the grease or the scales. A physician should be consulted both as to the diagnosis and the treatment. It is often not especially difficult to cure. Dandruff should be cured not only for its own sake, but because it is sometimes related to a poor complexion and possibly to baldness.

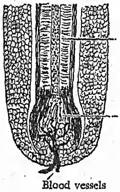


Fig. 162.—Cross section of a hair follicle, showing its blood supply.

Hair Tonics.

The nourishment of a hair comes entirely through the blood vessels at its root (see Fig. 162). Nothing applied to the scalp nourishes it except indirectly by improving local circulation. In most cases, brushing provides adequate stimulation of circulation. Many so-called hair tonics are alcoholic solutions that dissolve excess sebum and scales and improve the appearance of the hair temporarily. While these may do no harm, they may dry both scalp and hair too much. Whenever it is suspected that medication is required, it should be prescribed by a physician for individual needs.

Waving.

In cross section, a straight hair is nearly round, whereas a wavy or curly one is elliptical. A combination of mechanical methods (stretching and winding) with chemicals to soften the hair and heat to "cook" it will cause a straight hair to become elliptical and wavy, and to remain so until it is shed or cut off. Such methods of permanent waving do not improve the quality of the hair—for example, they often dry it, destroy its lustre and "life," and slightly discolor it. But if skillfully done, the total effect may be an improvement in the

appearance. In any case, it is a question almost entirely of appearance, for the health of the scalp and the future growth of hair are not usually affected.

Finger waving makes use of a lotion, usually with a quince seed base, to soften the hair, and of heat to "set" it. The main danger is not to the hair or the scalp, but to the skin of the face and also to the ears. Only moderate heat should be used for drying. The current of heat should not fall upon the face, and the ears should be fully covered.

Eyelashes.

The chief measure that may be used to protect the eyelashes is to make sure that no infection of the eyelids occurs and that the eyes are not strained. Any congestion or swelling of the lids may cause enough pressure on the roots of the eyelashes to destroy some of them and cause them to be shed. Nothing may safely be done to change their color, or to increase their number, or to improve their appearance.

F. COMMUNICABLE SKIN DISEASES AND INFESTATIONS

Ringworm.

This disease when it occurs on the feet is known as athlete's foot. It may occur on other parts of the body such as the groin or the arm pit. Elsewhere than on the feet the disease causes reddened areas with well-defined margins redder than the center. On the feet the common type of ringworm appears chiefly between the toes. The skin presents a pale, water-logged appearance and is easily rubbed off in scales, leaving a slightly red surface. There may be red, irritated fissures. Occasionally ringworm of the foot occurs as an acute infection, with blisters which rupture, and considerable soreness.

If not cared for, ringworm tends to persist indefinitely. In cases of long-standing foot infection the nails may become thickened, dark in color, and raised from their beds.

The prevention of ringworm is by avoiding contact with surfaces bearing the fungi (trycophyton). Ringworm of the body is often transmitted by exchanged clothing. Ringworm of the foot may be acquired in the same way, but it usually is acquired from infected floors, especially in bath rooms and swimming pools.

When several persons use a bathroom in common, certain precautions are necessary in order to avoid the transmission of infection

from one to another. The tub, being of extremely dense material, does not harbor bacteria if thoroughly scrubbed, rinsed in hot water, and dried with a clean towel, by each user. The floor in a bathroom is in a different category. If a person with the skin infection athlete's foot steps upon it barefoot, the fungi of this disease will survive there for some time. The disease is very common, and many of those who have it do not suspect it. To avoid taking or giving athlete's foot, it is essential that both the infected and the non-infected avoid barefoot contact with floors used by others. The safest procedure, even in homes, is to step directly from slippers into the tub, and to keep rubber slippers on the feet in the shower. At swimming pools, various solutions are used to minimize the danger.

Except in the case of the nails, treatment of ringworm is usually effective, although laborious.

Impetigo.

Impetigo is a local infection of the skin caused by several bacteria, acquired through contact with an infected person or articles recently soiled by discharges of the infected. Although it is more common on the face and hands, it may be widely scattered over the body unless sanitary precautions are used. The lesions are pustules, which run together and form a crusted area. They usually heal without scars. The chief danger of impetigo arises when it is located on the eyelids.

Scabies.

Scabies is due to infestation by a small animal parasite, the itch mite, acquired from others similarly infested. The first symptom is usually itching between the fingers, where minute grayish points may be visible (the burrow). By transfer, the entire body may be involved. Treatment is by means of medication applied according to a special technique. Reinfestation may occur unless clothing and bed-clothing are suitably treated. Others in the household should be examined.

Chapter 42

THE TEETH

Aside from being an advantage to health, a clean mouth and sound teeth have esthetic, social and economic advantages which most intelligent people fully appreciate. Nevertheless, the fatuous hope that the teeth will get along without due care causes many people to neglect them.

One in every five applicants for the United States Navy, according to recent statistics, was rejected because of bad teeth or other faulty conditions in the mouth.

CARIES AND ITS CONSEQUENCES

Caries.

Caries, or decay, of teeth begins with a break in the continuity of the enamel. This may be due to congenital defects or to mechanical violence. The immediate cause is the effect of acids produced by bacteria that ferment carbohydrate foods. After the enamel is weakened at a given spot, the acids and the bacteria find the softer inner structure of the tooth still less resistant than the enamel, and decay progresses, until there is an obvious cavity, which may finally extend as far as the pulp of the tooth.

Cavities are particularly likely to form in the crevices on the biting surface of the molars, especially on the first, or six-year, molars, and in the spaces between teeth where food becomes wedged.

Pulp Infection.

Unless checked, caries leads to infection of the blood vessels and nerves in the center of a tooth which constitute its pulp. This usually gives pain, for gases form in the decomposing tissue, and cause an increase of pressure within the tooth. Furthermore, the sensory nerves themselves feel pain sometimes even before infection has actually reached the pulp.

If left alone, the tooth dies of its own accord, but in the meantime infection may have spread downward to the apex and even into the jaw bone. If a dentist is consulted when pulp infection is present he will usually prefer to "kill" the nerve and disinfect the area as soon as possible.

Ultimately a dead or devitalized tooth turns a dark, brownish gray. It usually cannot be counted upon for many years of service. It is very likely to become abscessed, and should be watched with that in mind. The rule should be to have an X-ray examination of all dead teeth once a year. Even more important, teeth should be prevented from losing their vitality.

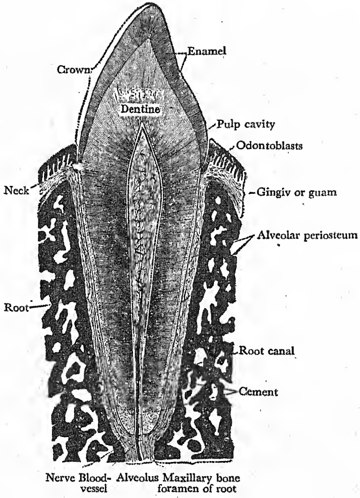


FIG. 163.—Microscopic view of the structure of a tooth in the jaw-bone. Note that the pulp cavity contains nerves and blood vessels that give the tooth life. (From Sobotta and McMurrich's "Atlas and Text-book of Human Anatomy," W. B. Saunders Company, Publishers.)

Apical Abscess.

When the pulp of a tooth is infected, the apex or root of the tooth is likely to become infected also. The infection proceeds by continuity, aided by the bubbling of gases during pulp infection. Although abscesses most often appear in devitalized teeth they may appear in vital teeth that are decayed.

The formation of an abscess usually causes pain, but unfortunately the pain does not always occur in sufficient amount to call

attention to what is happening until perhaps the abscess has extended widely. Sometimes there may be a slight swelling of the face or of the gum near the tooth. A "gum boil" is evidence of an abscess which is about to open on the surface of the gum. Most abscesses remain enclosed within the jaw bone until the tooth is extracted, although the jaw bone may become infected and either bacteria or their toxins may circulate away from the abscess to other parts of the body.

FIG. 164.—A tooth, showing cavity extending through all layers to the pulp, where an abscess A, has developed. (From Fones' "Mouth Hygiene." Courtesy of Lea & Febiger.)

Remote Damage from Infected Teeth.

Bacteria or their toxins may travel away from the teeth by means of (*a*) the blood vessels, or (*b*) the lymphatic vessels. If they travel by the blood stream, it is the joints that appear to be most likely to be damaged. Many authorities believe that infectious arthritis and perhaps other forms of rheumatism are often secondary to apical abscesses. Other diseases (e.g., kidney, heart) have also been traced to foci in the teeth. In fact, the teeth share with the tonsils the position at the head of the list as foci of remote infection.

When bacteria leave an apical abscess by the lymphatics, the glands of the neck most often receive the brunt of the infection, and they may enlarge and suppurate (form pus), leaving, perhaps, unsightly scars.

Other parts of the body that are sometimes infected by extension from the teeth are: the thyroid gland, the tonsils, the eyes, and the nasal sinuses in the cheek bones. The latter infection is particularly likely in the case of the upper teeth whose roots actually extend into the antrum.

THE HEALTH OF THE TEETH

To be sure of strong teeth, it seems that one must be born with them potentially sound, and then must give them meticulous care from several points of view, beginning early in life, and continuing throughout life. With such a foundation and such care, the teeth should give a life time of good service and cause little trouble and only moderate expense.

Favorable Prenatal Factors.

It was formerly thought that poor tooth structure was hereditary. This may be true, for there are many families in which caries is especially prevalent; but some authorities believe that, even though caries is present in many members of a family, it is acquired by each, and not inherited.

Unquestionably the major factor in influencing the soundness of teeth is the diet of the mother before the child is born. The first set of teeth are in an advanced stage of development at birth—in fact, occasionally a tooth erupts before birth—and the second set are well started in their growth. During intrauterine life the teeth may be made potentially strong for life.

The diet of the expectant mother must contain all of the nutritive essentials; although calcium, phosphorus and vitamin D are of direct importance, it is thought that no dietary essential can be omitted without interfering with the use of all the others.

Diet.

For a time after birth, while the teeth are still developing, the diet is still of the utmost importance in forming sound teeth. Until full growth is attained, it remains of great importance. It is generally agreed that at any time in life one of the advantages of a complete diet (i.e., containing all essentials) is that it may be as valuable to the teeth as to other tissues. However, the teeth are different in their structure from the soft tissues of the body, and do not carry on as active metabolism. Therefore it seems unwise to count upon even the best of diets to overcome local neglect.

Many authorities are firmly of the opinion that the opposite is equally true—that one cannot count upon the best of local care to

overcome the harm of a faulty diet. It has been stated by Boyd that "Under strict dietary supervision, the softened dentin at the base of a dental cavity will become stony hard in the course of a few weeks, and further spread or reactivation will not occur as long as the diet is continued."

Experiments have been done on growing guinea pigs, giving them alternately a good diet and a poor one. It is possible thus to produce alternate rings of sound enamel and of impaired enamel on erupting teeth.

It is even possible to neglect the local care of teeth entirely, as do the peasants of some races, without damaging them at all, if the diet is such as to give them good structure and good resistance.

Local Effect of Carbohydrates.

There is very convincing evidence regarding the part played locally by carbohydrates, especially sugars, in the chemistry of tooth decay.

Much evidence shows that the presence of free sugar in the diet has the effect of increasing the number of the acid-producing bacteria in the mouth and, at the same time, caries. In experiments with children in institutions, the rate of caries increased during the time when they were permitted candy, and decreased during the time when they were denied it.

However, it appears that the original soundness of the teeth may make a difference in this local effect of sugars, since in animals that are subject to caries (e.g., dogs), solutions of sugar and bacteria may even be experimentally allowed to adhere to the teeth without producing caries if the teeth are soundly developed.

Repair of Caries.

There is no known way by which decay can surely be prevented from starting. But there is an excellent way by which decay can br prevented from progressing. There is universal agreement that regardless of whatever else is done to protect the teeth, visits twice a year to a good dentist offer the best chance of preserving them. The only way to prevent both disease and loss is by removal of caries and filling of cavities.

If all decay is removed by carefully cutting it away, and the cavity is filled with a suitable hard, durable material, the tooth is almost as good as new. Decay will not occur again in that spot. If a filling is properly placed it will remain there indefinitely. If its edges form a firm union with the tooth, decay is not likely to occur

around it. If the material is carefully chosen, it is not likely to crack or break.

In view of the chemical problems involved in the choice of materials for filling, and the mechanical problems involved in placing them properly, it is obviously desirable to secure the services of the best dentist available—that is, one who is a graduate of a Grade A dental school, and stands well with other professional people in the community.

The dental hygiene program is today founded upon control of decay rather than prevention. If the diet is correct, the teeth kept clean, and several other points mentioned in this chapter are applied, the results may be so good that the dentist will find little to do at the semi-annual visits. But the visits must be made in any case.

A large clinic computed that if a child began to have regular dental care at 2 years of age and continued until 60, the cost at clinic prices would have been $357.20, and the teeth would have been saved; but that if dental care were begun later and were irregular, the cost, again at clinic prices, would have been $811.10, and the teeth would have been lost and false teeth would have taken their place. Multiplying the clinic cost by five to arrive approximately at the fee for the private dentist, and dividing by fifty-eight, we obtain the annual cost of $30.50 to save the teeth by early and regular care, as contrasted with $70.00 annually to lose them by delay and neglect.

Mechanical Injury.

Any small breaks in the enamel will surely give rise to caries. They should be repaired at once, for delay allows food to collect and decompose, and bacterial activity to commence. Still better, such breaks in the enamel should be prevented. The teeth should not be used to bite hard objects of any sort, even hard candy. Nor should hard objects (pins, etc.) be used to remove particles of food from between the teeth, or to scrape off adherent tartar. Although dentists use sharp instruments, the layman who does so is very likely to scratch the enamel enough to make it a prey to bacteria. If a tooth is broken by accident, a dentist should be consulted at once.

Chewing.

The health of the teeth, and also of the gums, is greatly aided by the eating of foods that require chewing. The vascular membranes about the teeth need this stimulation to keep them healthy. Moreover, the flow of saliva is increased when chewing is vigorous, and

this in itself is thought to be good for the teeth, for there appears to be greater susceptibility to caries in a dry mouth.

In those who live on a soft diet for a considerable period, the gums may become somewhat spongy and bleed readily, unless their stimulation is accomplished by the correct use of the tooth brush. The same results may occur on one side of the mouth if all the chewing is done on the other side.

Of course a satisfactory occlusion is essential to satisfactory chewing. When the teeth bite as they should, the circulation is activated all around the tooth and even in its pulp and in the gums. When the front teeth protrude, and do not meet the lower teeth, inflammation of the gums around both sets of teeth is very common. From the point of view of chewing, it does not matter what is chewed, but there are objections to the chewing of substances other than food unless they meet the sanitary standards for mouth cleanliness.

Good Occlusion.

Normally the teeth are placed in the mouth and are so shaped that they form a set of thirty-two structures that meet or occlude in a favorable position for biting and chewing. The placement and contour of each tooth is such that it corresponds with the placement and contour of the opposite teeth, so as to provide for the up and down motion of biting and the rotary motion of chewing.

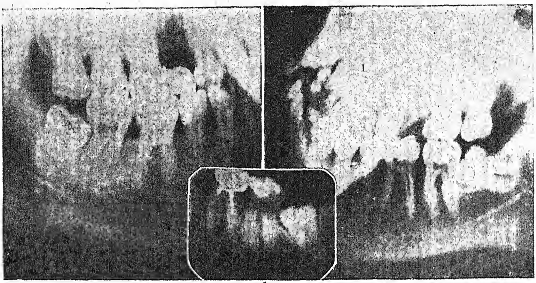
The causes of malocclusion are chiefly (*a*) heredity of a narrow jaw; (*b*) mouth breathing in childhood, from enlarged tonsils, adenoids, or some other cause; (*c*) extraction of teeth, which allows the others to drift out of position; and (*d*) fillings placed so as to cause "high spots" where they should not be. The first two of these causes usually give conspicuous facial deformity; the latter two do not. In either case, the bite should be corrected if possible.

If the teeth do not occlude properly, a number of results may follow. (*a*) The teeth suffer mechanical injury when biting and chewing take place at faulty angles, for the enamel will be unduly worn down in spots. (*b*) The gums may be partly separated from the teeth. This is probably the most common cause of the soreness of the gums that leads to pyorrhea. (*c*) Caries is more likely to occur in teeth that are not used in chewing, or are mechanically injured in chewing, or are injured indirectly as a result of gum injury. (*d*) The health may suffer because the food eaten is swallowed before it has been sufficiently chewed. (*e*) The health may

suffer because not enough food is taken, owing to discomfort in chewing; or because liquids and semi-solids replace solid food and bulk in the diet.

If malocclusion is detected in childhood, the remedy is orthodontia ("regulating" or "straightening" of the teeth). In some cases this treatment can be expected to give good results even in the 'teens.

Throughout life the best of dental care should be obtained regularly, to avoid the danger of malocclusion resulting from unskilled placement of fillings or from extraction.



a b c

FIG. 165.—Lower third molar impactions. (a) Slight impaction. Male—white—age 26. (b) Vertical impaction. Female—white—age 38. (c) Impacted third molar with crooked roots. (Miller "Oral Diagnosis.")

Extraction.

A decayed tooth is not pulled unless the process of infection cannot be stopped by other means. Sometimes it is necessary to extract a tooth with pulp infection; and usually, one with an abscess at the root.

Except when another tooth will erupt to fill the gap, the space formerly occupied by a tooth should be immediately filled in by a brace, a bridge, or an artificial tooth. This is in order to maintain the shape of the jaw, and to keep the teeth in proper biting relationship to each other.

In the case of the first teeth, it is very unfortunate if one of them must be prematurely lost. They should practically shed themselves. A large proportion of dental trouble arises as a result of decay and extraction of the six-year molars. Appearing at so early an age,

they are often mistaken for teeth of the temporary set and no effort made to preserve them. Their loss changes the occlusion of the teeth and directly predisposes to loss of health of the other teeth and of the gums.

The only permanent teeth that often require extraction through no fault of their owners are the third molars or wisdom teeth.

Wisdom Teeth.

The third molars (the so-called wisdom teeth) are no different from the other teeth except that they are located farther back in the mouth; and that they are more likely to be crowded for space. In the latter case they may erupt at an angle, or become wedged or impacted and fail to erupt at all. The wisdom teeth are more subject to decay than any others except the six-year molars, possibly because they are so far back that they are often inadequately cleaned. They are likely to be the first teeth that must be extracted. Wisdom teeth that are impacted usually need extraction.

Cleaning the Teeth.

For most people, great care is needed to prevent an undue accumulation of food debris and of a sticky substance called mucin, which is deposited from the saliva. Unless the teeth are frequently and thoroughly cleaned, the enamel will be coated with an opaque film which hides its lustre and forms a better lodging place for bacteria than does smooth enamel.

It is undeniably hard to keep the teeth absolutely clean. Thirty-two different structures, set near together, yet with a little space between, and surrounded at their base by soft tissues that are loosely adherent to them at the margin, offer some difficulty. Nevertheless, the aim should be to keep the surfaces of the teeth smooth and shining all around.

The mouth should be cleaned after eating and before retiring. In the morning the mouth will also need cleaning before breakfast, for in many people mucin deposits overnight. The total number of cleansings of the mouth and teeth in twenty-four hours will therefore amount to five—morning and night, and after each meal.

As a means of cleaning the teeth there is no good substitute for the bristle brush, supplemented by tooth powder or paste, dental floss, and possibly a mouth wash.

The Toothbrush.

Two matters are of importance in connection with brushing the teeth: (*a*) the choice of a brush; (*b*) the care of the brush.

(*a*) *The Choice of a Brush.*—It is well to choose one that is not more than medium in size. Many people find that they obtain better results with a brush of small size. The bristles should be of medium length. If they are too long they are likely to be too flexible to serve the purpose intended. The brush should be stiff. In brushing the teeth, cold water should be used on the brush, for hot water softens the bristles and makes them less effective. The tufts of bristles should be fairly widely spaced, each tuft having bristles of different lengths.

(*b*) *The Care of the Brush.*—A new brush should always be soaked in cold salted water for twenty-four hours before it is first used. After using the brush, it should be rinsed thoroughly, and kept in a place where it will not be handled by others or come in contact with the brushes of others. The brush should dry thoroughly between each using of it. If it is left out in the open air it may become contaminated by dust, but this is a lesser evil than putting it in a dark enclosed place where it will remain damp and thereby be a breeding place for bacteria from the mouth that remain on it even after due rinsing.

From time to time, perhaps once a week, the brush should be washed in ammonia water and dried in the open sunlight.

After an infection the brush should either be most thoroughly cleaned, or, preferably, cast aside, as any bacteria remaining on it may cause a re-infection. (The care of the mouth is always of great importance during an infection.)

It is a good practice to have two brushes simultaneously in use, and to alternate in using them, so that each has a chance to dry before it is used again.

There is difference of opinion among dentists as to the most satisfactory motion to be used in brushing the teeth and gums, for which reason the individual would do well to adopt the method his own dentist recommends.

Tooth Powder and Paste.

On the brush may be used any of the standard tooth powders or tooth pastes. These have, as a rule, little value as antiseptics, and need not be chosen with that in view. Their virtue lies in mechanical polishing of the teeth, for which purpose they contain a gritty substance (usually powdered chalk). In the Middle Ages, ground marble was used as a dentrifrice, probably with disastrous effects. The aim is to polish but not scratch the enamel.

Whatever powder or paste is used it should not be too gritty; and it should be thoroughly rinsed away.

Soap may be used for one or two of the daily cleansings of the teeth but it is too smooth to be relied upon entirely. Sometimes salt is of advantage for an occasional cleansing, but it usually is too drying for daily use on normal gums.

No special substance, not even any highly advertised dentifrice claimed to have virtues all its own, should be used without consulting one's dentist.

Mouth Washes.

For rinsing the mouth after cleaning the teeth, plain water is usually all that is needed. There is no objection, however, to using mildly antiseptic mouth washes, if they are more agreeable than plain water. Some dentists advocate special solutions for their effect on the gums.

In regard to the use of mouth washes as deodorants, it should be apparent that these are often useful, but not when any form of treatment will remove the cause of the odor.

Mouth washes to change the chemical reaction of the saliva should not be used except at a dentist's advice.

Dental Floss.

The use of dental floss to clean between the teeth is essential. It should be used as regularly as the tooth brush. Before using it, the hands should be thoroughly washed, to avoid carrying bacteria into the mouth during the necessary manipulations.

Floss should be pressed gently between the teeth, so as not to cut the gum, and then drawn back and forth to polish the surface of each of the adjacent teeth, as far as the gum. In removing it, care need not be taken not to dislodge fillings, for any filling loose enough to be removed in that way needs to come out and be replaced.

Professional Cleaning.

In spite of adequate daily care, most teeth will profit by professional cleaning by a dentist or a dental hygienist at least twice a year. This is particularly necessary in the case of those on whose teeth stains from tobacco accumulate or a deposit of tartar occurs.

Tartar.

Tartar is composed of mineral salts, food debris, and bacteria. The minerals are from the saliva. It is thought that the diet and certain chemical conditions in the body affect the saliva in such a way as to cause its minerals to be thrown out of solution and deposited on the teeth. The deposit of tartar is most often found

near the openings of the salivary ducts (i.e., the inner side of the lower front teeth and the outer side of the upper back teeth).

As it is first deposited, tartar is not hard, but it becomes so within ten or twelve hours. Obviously, if the teeth are very carefully brushed at intervals of less than twelve hours such deposits should not form.

Tartar does not seem to be associated with any form of general ill health, and it does not seem to harm the teeth greatly; but it is definitely irritating to the gums and may cause a train of events that leads finally to pyorrhea.

THE GUMS

The root of each tooth fits into a bony socket in the jaw bone, and the mucous membrane that covers the jaw bone is prolonged upward a short distance around the base of each tooth. In this location the membrane is called gingiva or gum.

The gums should be light red or pink, thin, and firm. If they are bright red or purplish red, or soft and spongy, thickened, and easily made to bleed, they are abnormal. Even though the gums as a whole are normal, there may be one or two small areas of abnormality, as described. No matter how small, an area of gingivitis should receive attention. The treatment of any inflammation of the gums should be under the direction of a physician or a dentist.

Causes of Gingivitis.

The commonest causes of gingivitis are: (*a*) lack of sufficient vitamin C in the diet; (*b*) mechanical irritation; (*c*) infection of the type known as "trench mouth"; and (*d*) pyorrhea. The relationship of vitamin C to the gums was mentioned in the discussion of scurvy (page 345). The other three causes of gingivitis will be separately discussed.

Mechanical Causes of Gingivitis.

Normally the gums adhere to the surface of the teeth, but the union is not very close. The gums may readily become loosened from the teeth at their margins unless special care is taken to prevent this.

The health of the gums largely depends upon the ability to use all of the teeth in biting and in chewing, and their actual use for these purposes. The gums are exercised in this way, and circulation through them is improved. They are apt to become inflamed about teeth that are not used regularly and vigorously.

The occlusion of the teeth must be correct in order to have the gums derive the greatest benefit from chewing. If the teeth do not meet properly, some one (or more) of the teeth will strike another at a disadvantageous angle, and at every bite the gums around such teeth will be pulled slightly away from them, and thereby irritated. The faulty placement that causes this difficulty may be very slight. In fact a single unskilfully placed filling may cause traumatic occlusion and be responsible for gingivitis.

Other ways in which the gums may be mechanically injured are the faulty use of the toothbrush or of dental floss and the accumulation of tartar on the teeth at the gum margin.

"Trench Mouth."

This infection of the mouth was given this name during the World War, when it was both prevalent and serious among men in the trenches. Although serious cases still occur, it is now more often a rather mild acute infection limited to the gums. It causes the gums to look inflamed, and gives a bad odor to the breath.

Since it is very readily communicable, special precautions not to pass it on to others must be taken by those so afflicted (i.e. avoidance of direct contact, and of indirect contact through eating utensils, etc.). A case which is mild in one person may be a severe and even a fatal infection of the whole mouth and throat in another.

The disease is diagnosed by a microscopic examination of the moisture about the gum margin, and the finding of the Vincent organism (a spirillum, with a fusiform bacillus). This organism gives the infection its scientific name, Vincent's infection, or Vincent's angina.

Pyorrhea.

Pyorrhea means literally a flow of pus. As commonly used, it describes an infection of the gums by pus-forming germs. Undoubtedly it causes greater foulness of the breath than any other ailment, and the odor can scarcely be masked.

Ordinarily pyorrhea is preceded by inflammation from mechanical or metabolic causes. Most cases would not occur if the gums were carefully watched for any departure from normal, and were suitably treated at the start.

Pyorrhea always needs the attention of an expert dentist, preferably one specializing in this particular branch of oral medicine (i.e., a periodontist). It should be attended to early, as the soft, receding, infected gums ultimately fail to hold the teeth in place, and the bony sockets of the teeth disintegrate, making extraction

necessary. Furthermore, the absorption of pus may impair the general health. There is no tooth paste or powder, and no mouth wash, having specific power to prevent it or to cure it. Each case needs individual study.

Massage of the Gums.

When the gums are healthy, sufficient massage can be secured while brushing the teeth if the brush at each stroke be placed upon the gums well beyond the gum margin and moved toward the tooth margin. This should be done whenever the teeth are brushed. If the effect of a stiff brush and cold water is not agreeable, it should be suspected that the gums are not healthy, or that the method is not correct.

When the gums are not healthy, a special type of gum massage with the toothbrush may be required, with a brush designed for the purpose, and used according to the dentist's directions.

Chapter 43

REPRODUCTION

The health of the reproductive system is of interest from two main points of view: first, as it concerns the individual in his own life; and second, as it concerns offspring. The latter subject will be discussed in the next chapter. Sex is not, however, a purely physical matter; it has certain important psychological implications, which will be discussed in the chapters on mental hygiene.

Simple and Complex Methods of Reproduction.

To reproduce its kind is characteristic of all living things. The simpler the organism, the simpler the process of reproduction. Single-celled organisms (e.g., bacteria) reproduce by simply dividing into two parts: each part then becomes a whole, and is itself capable of reproducing two more cells. This is asexual reproduction or cell division or fission.

A little higher in the scale of life, two sexes appear, and reproduction occurs by the union of one cell each from the male and the female. Special cells are set apart for this purpose only. The new-organism begins as a single cell formed from the two cells from the parents, but this cell divides and subdivides and undergoes such development as will finally cause it to resemble the parent stock. Plants and animals alike reproduce thus.

The process of reproduction, however carried on, consists of the separation of a part from the whole of a living organism to form new separate individuals. The chief differences between simple fission and the more elaborate sexual reproduction are: (*a*) in the case of fission, the parent ceases to exist when the two offspring are created, whereas in other types of reproduction the parents continue to live as before; (*b*) it takes only one parent to reproduce by fission, whereas it takes two to reproduce most forms of life beyond the unicellular.

In many of the lower forms of animal life, the male and the female each deposit the reproductive cells outside the body where they unite and develop. In the mammalia, or highest-form of animal life, the two cells unite within the body of the female and the off-

spring develop there for some time before they are born into the outside world.

In the following pages will be discussed reproduction as it occurs among humans: *A*. the reproductive functions, of the male and of the female; and *B*. the associated recurring functions in each sex.

A. THE REPRODUCTIVE PROCESS

Essential Reproductive Organs.

In both sexes, the essential organs for reproduction are the *gonads*, or glandular structures that produce the sex cells, and the *tubes* through which these cells pass on their way toward union. In the female there is also a sac to hold the child before birth. Other parts of the reproductive system, which will be mentioned in the next two sections, are accessory to these.

The reproductive organs are formed before birth, and they continue to develop during childhood, but do not attain full development or functioning ability until puberty.

Sexual Maturity.

Puberty is the beginning of adolescence (becoming adult). It occurs from eleven to sixteen years of age, according to the activity of the pituitary gland, the gonads, and certain other endocrine glands. Usually it is slightly later in the male than in the female. Too early or too late puberty may have medical significance.

At puberty the essential change is that the sex glands take up their function of producing sex cells that are capable of reproduction. Although parenthood is possible in most cases at any time after puberty begins, it is not physiologically suitable until adolescence is practically complete.

The characteristics that differentiate the adult from the child, and the adult male from the adult female, are the result of changes in the gonad secretions that take place at puberty. In both sexes, physical and mental changes occur as evidence of maturity.

In the male the voice deepens, hair appears on the face and body, the body becomes more angular and muscular, and the function of emission begins. In the female the pelvis widens, the subcutaneous fat becomes more abundant, especially about the breasts and hips, the mammary gland tissue increases in amount, hair appears about the external genitals and under the arms, and menstruation begins.

In later adolescence if not at puberty, in both sexes there usually appears an interest in the opposite sex. This may be merely on the

plane of companionship, or of intellectual interest, or it may be a tendency to fall in love. Impulses that are definitely sexual may or may not develop during adolescence.

The period of adolescence lasts until eighteen or twenty years of age. It is characterized by the final attainment of sexual maturity and normally of fitness for parenthood.

The duration of the functioning sex life is until forty-five or fifty years of age in the female and usually until old age in the male. Its cessation in the female is called the climacteric or the menopause. The chief changes in the female at that time are loss of reproductive power and the absence of the associated function of menstruation with, in some cases, waning of the sex impulse, and certain symptoms indicative of the general change in endocrine gland function. In the male the conclusion of the reproductive life is gradual and usually not definite.

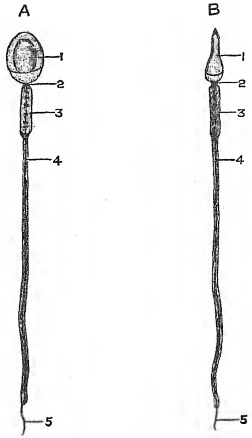


Fig. 166.—Semi-diagrammatic representation of human spermatozoa. A, front view; B, side view. 1. Acrosome, surrounding head; 2, neck; 3, middle-piece; 4, tail; 5, end-piece. The axial filament runs through the body and tail into the end-piece. (Halliburton.)

a. The Male

Spermatozoa.

In the male as in the female, the essential parts of the reproductive system are the glandular structures that produce the sex cells. These cells in the male are called sperm cells or spermatozoa. They are very small cells, long and narrow in shape, with an enlargement at one end containing the nucleus, and a slender tail-like body.

By a whip-like motion of the body, the spermatozoon is able to propel itself. This motion is used to enable it to travel from its point of entrance into the female reproductive tract until it reaches a female sex cell. Aside from possessing motility, these cells possess great vitality, which enables them to survive perhaps for many days after they have entered the female organs. Since they are produced

and discharged in prodigious numbers at a time, it is always likely that sex union will result in conception.

The Testes.

The organs in which the spermatozoa are produced are called the testes or testicles. They are located in a pouch of skin and muscle, called the scrotum, suspended from the lower part of the male pelvis. The scrotum is lined with serous membrane and contains

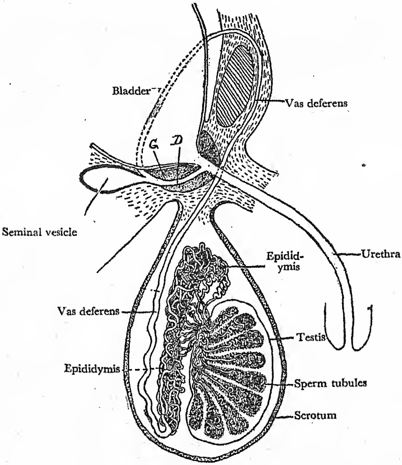


FIG. 167.—A diagram of a sectional view of the essential sex organs of the male, chiefly through the middle plane of the body. *D*, ejaculatory duct, *G*, the prostate gland. (From Galloway's "Biology of Sex," in Bundy's "Anatomy.")

the two testes with the tubes leading from them. Each testicle is about the size of a walnut. It consists of two parts, a cellular portion which produces the sex cells, and a tubular part called the epididymis. The cellular portion consists of about 800 very fine coiled tubules, each more than a foot in length when unravelled. From the lining of these tubules the spermatozoa are formed.

From cells which lie between the tubules is produced the internal secretion which furnishes the primary sex characteristics and impulses, and also the secondary ones that give male physical quali-

ties. These cells are called interstitial, because they are found in the connective tissue between the sperm-bearing cells.

Sperm Ducts.

The sperm tubules in the testicle unite to form the tubes of the epididymis, which later in its course is called the vas deferens. This tube leaves the scrotum and winds upward in front of the pelvic bones in the groin, enters the abdomen and proceeds to the seminal vesicles, located between the bladder and the rectum. The fluid from the testes is collected in these vesicles, from which the seminal ducts lead outward to empty into the urethra. The route of the seminal ducts lies directly through a gland called the prostate.

Seminal Fluid.

In its final form the seminal fluid, or spermatic fluid, or semen, consists of a thick whitish albuminous liquid which comes chiefly from the tubules of the testicles, the seminal vesicles and the prostate gland. It serves as a vehicle for the spermatozoa. Only a small amount of it is discharged at a time, the interval varying according to the rapidity with which it forms, but each discharge ordinarily contains millions of spermatozoa.

External Organs.

The seminal fluid leaves the body by means of the urethra, the tube from the bladder. This tube passes down through the penis, an organ which contains muscle tissue and also many blood vessels that are capable of being greatly engorged. When distended thus the penis becomes larger and firmer for its introduction into the vagina during coitus, to place spermatozoa in a favorable location for coming in contact with an ovum. Because it becomes more erect when it is thus engorged the process is known as erection. Although erection is physiologically purposive it takes place at times under other circumstances, either as a result of local stimulation, such as that produced by the accumulation of semen, or as a result of psychic stimulation by erotic thoughts or emotions.

b. The Female

The female reproductive organs consist of the *ovaries* sex glands analogous to the testes in the male; the *oviducts;* the *uterus;* and the *vagina.*

The Ovaries.

The ovaries are small glandular organs about the size and shape of a large almond, located one on each side of the pelvic cavity.

They contain a large number of single cells, called ova. Each ovum is contained in a small sac called a Graafian follicle. At 17 or 18 years of age there are approximately 5,000 ova in each ovary. Some are still immature in form, others are larger and more fully developed, and a few others are at their full maturity. The most mature ova will be found near the surface of the ovary.

Aside from producing ova, the ovaries also produce internal secretions, which cause the female characteristics to appear at puberty.

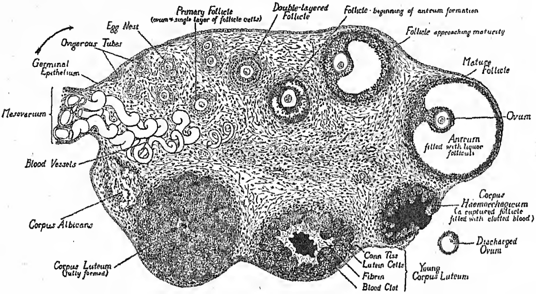


FIG. 168.—Schematic diagram of mammalian ovary. Follow clockwise around the ovary starting from the arrow: note first two stages in formation of ovum from the germinal epithelium, and then successive stages in growth of ovarian (Graafian) follicle, until ovum is discharged, after which the corpus luteum forms. (Patten, "Embryology of the Pig.")

Ovulation.

The ovaries perform the function of ovulation. This consists of the maturing of an ovum and its extrusion from the ovary.

As an ovum begins to mature it enlarges and the fluid in its surrounding sac, the Graafian follicle, increases in amount. The whole follicle becomes much larger. Eventually the follicle is in contact with the surface of the ovary, and the fluid in it is under tension. Shortly it ruptures, and the ovum is discharged into the pelvic cavity. (See Fig. 168.)

Ovulation usually occurs every twenty-eight days, from puberty to the menopause. Usually only one ovum matures at a time.

The purpose of ovulation is that of preparing an ovum for union with a sperm cell. Although partly mature when it leaves the ovary, it requires further development, which takes place in the oviduct.

The Oviducts.

The oviducts, or Fallopian tubes, extend horizontally sidewise from the uterus. The outer end of each oviduct is open, and lies near one of the ovaries. After an ovum is discharged from an ovary, it is taken up by fine finger-like processes on the end of one of these tubes. The tube is lined with ciliated mucous membrane, the cilia having their strongest motion in the direction of the uterus.

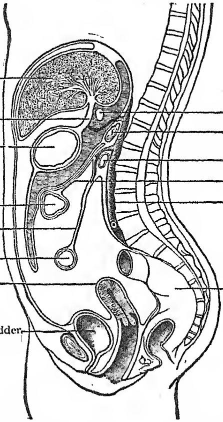


FIG. 169.—Diagram to show a cross section of the female genital tract. The section passes through the middle plane of the body, and thus does not show the Fallopian tubes and the ovaries, which are located at either side of the uterus. The walls of the vagina are ordinarily in contact with each other, and its opening is partly closed by the hymen in the virgin. (Bundy.)

The ovum is therefore waved along at a slow rate through the tube. During its passage it concludes the process of maturing, and by the time it has reached the middle of the tube it is ready for fertilization by a sperm cell.

Fertilization.

The process of fertilization consists of the union of a sperm cell with an ovum. The sperm cells in the seminal fluid are deposited in the vagina in the act of coitus, or sexual intercourse, and from there travel to the oviducts. If an ovum is present in the oviduct the sperm cells swarm about it, and finally one of them becomes united with it.

Thus fertilization or conception is effected. Thereupon the other spermatozoa seem to be actively repelled; they fall away from the ovum and soon perish. (See Fig. 171.)

The nucleus of the spermatozoon becomes fused with the nucleus within the ovum, to form a new single cell, consisting of the entire ovum and the nucleus of the sperm cell. This cell, the zygote, is the earliest stage in the life of the new individual.

As soon as conception (literally, the *beginning*) has taken place, the fertilized ovum moves along the oviduct until it reaches the uterus.

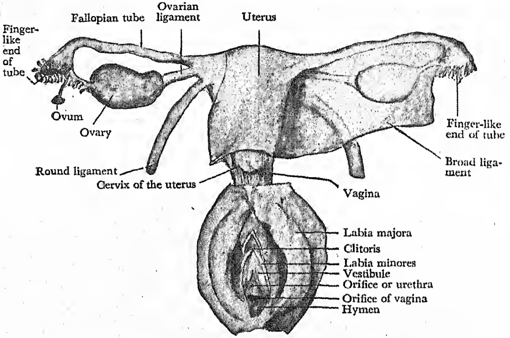


FIG. 170.—Reproductive organs of the female.

If fertilization does not occur, the ovum is eventually discharged from the body.

Fertilization cannot take place unless sperm cells arrive at a time when a mature ovum is present in an oviduct, and conditions are such as to favor the life of both cells.

Uterus.

The uterus (womb) is a pear-shaped organ composed of involuntary muscle. It has a potential cavity within it, but ordinarily its walls are in contact. The uterus is suspended in the broad ligament which stretches across the pelvis. It is also supported by other ligaments, but is rather freely movable. Ordinarily it is tipped at an angle, with the upper part nearer the front of the body, and is itself bent slightly forward. It lies behind the bladder and in front of the rectum. Many blood vessels supply it with nutriment.

There are three openings from the uterus. One leads outward through its neck or cervix into the vagina. The other two lead into the oviducts.

Implantation of the Ovum.

From the point in the oviduct where conception takes place, the fertilized ovum continues to travel toward the uterus, and very shortly becomes implanted in the lining membrane of the uterus.

Previous to the arrival of the ovum, certain changes have occurred in the lining of the uterus in preparation for its reception. The capillaries have become much distended with blood, in order to provide the fertilized ovum with abundant nourishment. This process begins at about the time when the ovum is reaching its maturity. It is brought about by endocrine gland action.

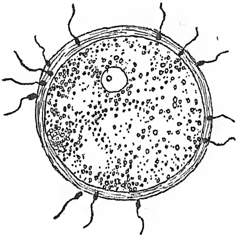


FIG. 171.—Ovum surrounded by spermatozoa. (From Burton-Opitz "Elementary Manual of Physiology," W. B. Saunders Co.)

Intrauterine Growth.

The fertilized ovum, having become the single first cell (zygote) of a new being, immediately begins its process of growth. First, it divides into two parts, each part containing an equal portion of the nuclear material and the contained inheritance substance (see Chapter 44), then into four, eight, sixteen, and so on.

The subsequent course of events in the developing embryo involves the continued rapid dividing and redividing of the cells as fast as they form, until there are the millions of cells that constitute the newborn child.

During cell-division the cells not only multiply but become differentiated into all the various varieties that make up the human body. Also, they arrange themselves in orderly fashion, so that each part and organ is practically the same in all human beings of the same sex.

At a very early stage in the subdivision of cells, there appear three layers of cells which begin to fold about in such a way as to form the dorsal and ventral cavities of the body. At about four months after conception the embryo has distinguishable eyes, ears, fingers and toes, and its sex is apparent. Shortly after that its heart

Thus fertilization or conception is effected. Thereupon the other spermatozoa seem to be actively repelled; they fall away from the ovum and soon perish. (See Fig. 171.)

The nucleus of the spermatozoon becomes fused with the nucleus within the ovum, to form a new single cell, consisting of the entire ovum and the nucleus of the sperm cell. This cell, the zygote, is the earliest stage in the life of the new individual.

As soon as conception (literally, the *beginning*) has taken place, the fertilized ovum moves along the oviduct until it reaches the uterus.

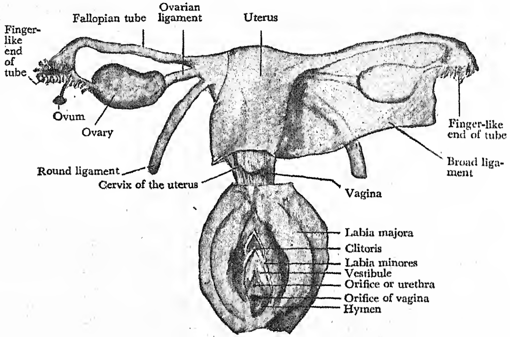


Fig. 170.—Reproductive organs of the female.

If fertilization does not occur, the ovum is eventually discharged from the body.

Fertilization cannot take place unless sperm cells arrive at a time when a mature ovum is present in an oviduct, and conditions are such as to favor the life of both cells.

Uterus.

The uterus (womb) is a pear-shaped organ composed of involuntary muscle. It has a potential cavity within it, but ordinarily its walls are in contact. The uterus is suspended in the broad ligament which stretches across the pelvis. It is also supported by other ligaments, but is rather freely movable. Ordinarily it is tipped at an angle, with the upper part nearer the front of the body, and is itself bent slightly forward. It lies behind the bladder and in front of the rectum. Many blood vessels supply it with nutriment.

There are three openings from the uterus. One leads outward through its neck or cervix into the vagina. The other two lead into the oviducts.

Implantation of the Ovum.

From the point in the oviduct where conception takes place, the fertilized ovum continues to travel toward the uterus, and very shortly becomes implanted in the lining membrane of the uterus.

Previous to the arrival of the ovum, certain changes have occurred in the lining of the uterus in preparation for its reception. The capillaries have become much distended with blood, in order to provide the fertilized ovum with abundant nourishment. This process begins at about the time when the ovum is reaching its maturity. It is brought about by endocrine gland action.

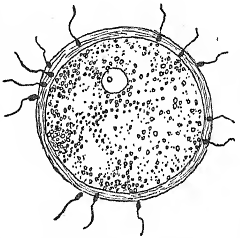


FIG. 171.—Ovum surrounded by spermatozoa. (From Burton-Opitz "Elementary Manual of Physiology," W. B. Saunders Co.)

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beat can be heard. In the later stages of development it is called a fetus.

Quite early there forms about the developing embryo a membrane called the amniotic sac, which surrounds the embryo entirely. In it is a fluid, in which the embryo floats. It acts as a hydraulic cushion to protect the embryo from too sudden or too severe changes of pressure from without.

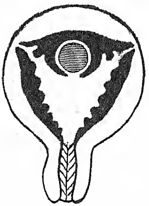


FIG. 172.—Thickened lining of uterus: showing imbedded ovum after impregnation. (Bundy.)

Nutrition of the Embryo.

All living things require nourishment, and this is true of the fertilized ovum from the moment of conception onward. At first it derives its nourishment directly from the blood vessels in the uterine membrane upon which it rests. Later, the embryo develops blood vessels of its own, and an elaborate system for the transfer of nutriment from the mother's blood to itself and of waste from itself to the mother's blood.

The embryo's blood vessels begin to form at one spot, and gradually develop at that spot into a structure known as the placenta. The blood vessels of the placenta interlace with those of the mother in the uterine wall, and they unite to form large vessels that lead to and from the embryo. These large vessels are contained in a cord (the umbilical or navel cord), and are attached to the embryo at the center of the abdomen, the umbilicus or navel.

The child's nutrition depends entirely upon the mother's diet. Whatever is available for the child's nutriment passes readily through the placenta and umbilical vessels, and the growing cells take what they need and discard their waste by the same route.

Other ways in which maternal health affects the developing child will be mentioned in the next chapter.

Birth.

The full term of intra-uterine life is approximately nine calendar, or ten lunar, months after conception. Birth, or delivery, of the child spontaneously occurs at that time.*

* *The termination of pregnancy before its full term is called abortion or miscarriage if the embryo or fetus is not living. The birth of a living child before full term is called a premature birth. The term stillbirth refers to the birth of a child at or near full term, but not living.*

During pregnancy the uterus increases enormously in size, and its muscle cells in size and number, so that it is capable of great contracting power, which it uses to expel the child at the time of birth. It is aided by voluntary contractions of the abdominal muscles. At the time of birth, the amniotic membrane ruptures, discharging the fluid, which flows outward and is of assistance in easing delivery. The child passes through the vagina, usually head foremost.

The term labor is applied to the intermittent, regular contractions of the uterus which result in delivery of the child. The process

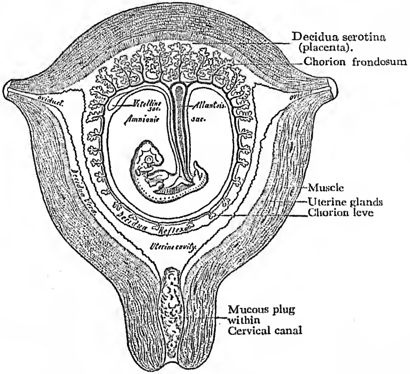


FIG. 173.—The relations of structures of the human uterus at the end of eight weeks of pregnancy. (From Edgar, after Thompson.)

usually lasts from two to ten hours, with labor pains first occurring at wide intervals and later becoming stronger and more frequent.

For a short time after the birth of the child the placenta remains attached to the uterus. The child is separated from it by clamping and cutting the navel cord near to the abdomen. Its healing forms the dimpled scar known as the navel.

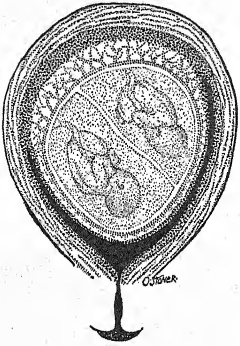
The remainder of the navel cord and the placenta and membranes are delivered within a few minutes. These structures are then called the "after-birth."

Although the process of birth is natural and often easy, expert assistance is always an advantage and sometimes absolutely essential for the life of mother or child or both.

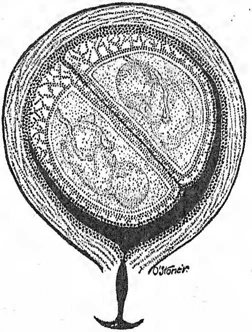
The Vagina.

Birth takes place through the vagina, a muscular tube which opens upon the exterior of the body. Its opening lies between the urethra from the bladder and the anus from the colon. Through it the menstrual blood is discharged and seminal fluid received.

In the virgin the opening of the vagina is partly but not wholly closed by a thin membrane called the hymen. This membrane is likely to be ruptured by chance during childhood, but often remains practically intact until the first sexual intercourse, at which time it



Uniovular twins



Binovular twins

FIG. 174.—Uniovular twins, with two umbilical cords and one placenta; binovular twins, each with separate cord, membranes and placenta. (From Schumann's "Textbook of Obstetrics, Courtesy W. B. Saunders Co.)

usually ruptures easily, with a small amount of bleeding. In some cases, the hymen does not rupture, but merely stretches.

Although potentially tubular in form, the walls of the vagina are ordinarily in contact with each other. However, it is capable of sufficient distention to admit of the passage of the child at birth, usually without injury. Occasionally it becomes torn at its external opening during delivery, and in such a case it must be immediately repaired by a stitch or two—a painless process.

The New Born Child.

The average weight of the new born child is seven and a half pounds, and its length about twenty inches. The child, as soon as it is born, gasps or cries and fills its lungs with air, and it is ready for postnatal life.

An infant does not "come to life" at birth, for it has been alive from the time of conception onwards. It has had, for some time before birth, its own heart and blood vessels and nerves. It has had all of its organs, some of them functioning as fully as they ever will, although in a somewhat different way.

It takes a little time after birth for some of the functions to become adapted to life in the outside world, but with intelligent care the new-born infant should be as hardy in its way as an adult. It is intrinsically a delicate organism, however, whose hygiene must be carefully regulated. Diet, sleep, sunlight, and protection from direct or indirect contact with infection, are especially important.

Lactation.

Lactation, or milk production, commences soon after childbirth, the mammary glands (breasts) of the mother having increased in size and taken up that function for the purpose of supplying the infant with its proper food.

The mammary glands or breasts are accessory reproductive organs in the female. (A non-functional breast is found also in the male.) They are masses of secreting epithelium, which do not function, however, until after delivery of a child. The inactive mammary gland is largely composed of fat and connective tissue, with gland tissue in rudimentary form.

Occasionally the mammary glands do not function properly after childbirth, which is unfortunate since the lacteal fluid, or milk, they secrete is usually the most suitable food for the infant.

Twins.

In some cases two ova, one from each ovary, mature and are fertilized at the same time, and continue their development together. This produces twins that are *heterologous* or unlike (except as brothers and sisters often resemble each other). In other cases, each of the first two cells formed by the first division of the zygote goes on to separate development instead of remaining together and forming one individual. Such twins are identical in sex and in all hereditary characteristics, and they will be precisely alike except as a result of what happens to them as they develop before or after birth. They are identical, *homologous* or single-ovum twins.

B. ASSOCIATED FUNCTIONS OF THE REPRODUCTIVE ORGANS

Aside from reproduction itself, in both sexes the sex organs manifest their activity during the reproductive period of life by certain

recurring physiological functions. In the male, emission takes place under certain circumstances; and in the female, menstruation occurs with considerable regularity.

a. Menstruation

Physiological Basis.

Just before an ovum is due to reach the uterus, the mucous membrane which lines the uterus becomes congested and thickened. This is for the purpose of providing a suitable location for a fertilized ovum to implant itself, be nourished, and grow. If the ovum is not fertilized, it does not implant itself, but passes out of the uterus; the congestion of the uterine membranes, no longer having any purpose, subsides, with a variable amount of oozing from the over-distened capillaries. This continues for three or four days, and is called menstruation. If the ovum is fertilized, menstruation does not usually occur again until after the delivery of the child, or indeed until after lactation has concluded.

Normally, menstruation occurs every twenty-eight days (from the first day of one period to the first day of the next), lasts from one to six days (usually three or four), causes a moderate flow of blood, and is not accompanied by pain.

Hygiene during Menstruation.

During menstrual periods no change need be made in one's ordinary routine, if the routine is a good one and the menstrual function is normal. Those with menstrual disorder may have to modify their habits somewhat until they are cured.

(*a*) *Exercise.*—A normal person during menstruation can do almost any sort of exercise without harm. Exercise that involves jumping or jouncing (e.g., basketball, tennis, horseback riding) might in some cases be injurious during the early days of the period, when the uterus is heavier than normal, for such exercise might possibly cause its supporting ligaments to stretch. This would apply particularly to those who are somewhat undernourished and have poor muscle tone. Regarding the amount of exercise, it should be noted that to avoid over-fatigue is discreet at all times, and particularly so during menstruation.

Students in most colleges are excused from physical education during menstruation, not because it would necessarily hurt the majority, but to safeguard the few who might be hurt. The only way to be sure that none suffer is to excuse all. Students are usually not permitted to play on teams during menstruation for the same

reason, and also because such a rule puts both teams on the same footing in regard to the chance of having players out of the contest.

(*b*) *Bathing*.—There is an old superstition that bathing during menstruation is seriously harmful. Such is not the case. The only possible danger comes about through chilling. The warm (not hot) tub or shower in a comfortably warm room is not only safe but desirable. The advisability of cold bathing depends upon one's personal reaction to it; usually it is not suitable during menstruation. Plunge bathing (e.g., in the ocean) offers still greater chance for chilling and on that account is still less suitable.

(*c*) *Chilling*.—Chilling of the body (by prolonged exposure to cold, or cooling rapidly when heated, or wearing wet clothing or wet shoes) seems particularly likely to cause congestion of the pelvic organs. It may even cause inflammation. Rather serious harm may follow chilling if it has been pronounced, and even slight chilling may give such symptoms as cessation of the period, and pain, or perhaps excessive flowing, for one or more periods thereafter.

Irregularity of Menstruation.

Absolute conformity to any given standard in respect to frequency, duration and amount of flowing is not essential for health and, in fact, is rather rare. If periods occur too often, last too long or are too profuse, the cause should be sought and corrected, because such conditions may produce anemia.

Ordinarily it is of little significance if the flow is scanty in amount and of short duration, or the interval longer than twenty-eight days. This is the case in some of the most vigorous women. However, if the periods habitually occur at long intervals it would be well to find out whether any abnormality is responsible for it—as, for example, a disorder in the endocrine glands. Absence of menstruation for the first few months of college life is not at all unusual, even in healthy young women. On the other hand, if accompanied by any symptoms of ill health, loss of weight or fatigue, it should be investigated. Occasionally, cessation of menstruation occurs at the onset of tuberculosis.

There need not be and should not be any self-prescribed treatment to bring on a delayed period. The same is true in regard to efforts to delay or to stop a period. All such efforts are either futile or harmful.

Dysmenorrhea.

There should be no pain or disability during menstruation. It is as normal a function as the digestion of food, and should cause no

more inconvenience. If pain occurs, it should not be accepted as inevitable without making an effort to find out what causes it and how to prevent it.

The menstrual pain located in the pelvic organs is known as dysmenorrhea, regardless of its type (dull or crampy) and regardless of its location (front, back, one side or the other, or low in the pelvis or vagina).

The constitutional symptoms that may accompany menstruation are probably most often of endocrine origin, since there is considerable readjustment among the endocrine glands at such times. They generally consist of weakness or lassitude of the body, and some depression of spirits. There are those, however, in whom the constitutional effects are good; apparently in some women the endocrine readjustments lead to an increase of energy and vigor before, during or after the period.

Reflex menstrual symptoms are those that come about through the transfer of nerve impulses from the pelvic organs to other parts of the body. Nausea and vomiting, headache and fainting are likely to be of this sort.

There is no reason for enduring any of these varieties of menstrual pain. Three methods are available for alleviating them: (1) the use of pain-relieving medicines; (2) improving physiological conditions that cause them, either by changed habits of living or by medical treatment; or (3) improving anatomical conditions by surgery.

Medicines for Dysmenorrhea.

If one can be content to bear recurring periods of semi-invalidism, menstrual pain can usually be relieved by staying in bed, applying a heating pad or hot water bottle, taking hot drinks and taking pain-relieving medicine. In some cases, the latter alone suffices.

It would appear illogical to accept the need for such measures without having medical advice on the matter. Furthermore, the choice of self-prescribed medicines may be a poor one. Many of the medicines advertised for this purpose contain amidopyrine, a drug notoriously unsafe (except as prescribed by physicians) because of the danger of causing a fatal disease of the blood.

Physiological Improvements.

In many cases menstrual pain, especially of the dull, dragging type, is due to pelvic congestion.

Such congestion may be the result of general sluggishness of circulation through the body, with more marked slowing in the rate

of flow through the vessels of the pelvis because they are at the lowermost part of the trunk, from which return circulation is difficult. This type of menstrual discomfort is especially common in those who sit a great deal and take little exercise.

Sometimes, however, pelvic congestion occurs in those with good circulation, and is purely local. In such cases the cause may be lack of the special kinds of exercise that use the muscles in the lower part of the trunk and stir up local circulation there (e.g., those that involve bending and twisting of the trunk).

Two conditions in particular are often responsible for pelvic congestion, and thereby for menstrual pain. They are poor posture and constipation. Either or both may be the chief cause, as can be shown by the improvement that usually occurs when these faults are corrected.

The type of poor posture that causes the most trouble is that which has previously been described as "slouching," which includes, in particular, a relaxed abdominal wall. In such cases the pelvic organs may be pressed upon unduly by the sagging of the organs above them, and the circulation of blood in them may be sluggish.

Constipation produces its bad results on the pelvic organs in much the same way, the overloaded colon exerting undue pressure upon them and hampering the circulation through them.

A common cause of pelvic congestion in the past was the pressure of clothing. In fact it appears that the health of the women of the past few generations owed its bad reputation very largely to the clothing then worn. Corsets were both tight and wrongly placed, and made pelvic congestion almost inevitable: at the same time they made any control of the abdominal muscles quite impossible, and limited the choice of healthful general exercise. If for no other reason than the abandonment of these unnatural garments, an improvement could have been expected in the health of the women of the present.

There is no particular objection to most of the girdles and corselettes that are worn today. In fact they are helpful in some cases as a means of supporting the organs and as a reminder to use the abdominal muscles, although no girdle should be relied upon to do what the muscles could be trained to do.

Sometimes dysmenorrhoea is related to a general condition of poor health, especially when anemia is present. It has often been observed that those who ordinarily have no trouble, may experience pain after living irregularly for a time and somewhat overtaxing

their reserves of strength. Those who habitually "burn the candle at both ends" are more subject to menstrual disorders, as well as to other disorders, than are those who arrange their lives more intelligently.

Medical Treatment.

In all cases in which pain is severe and requires loss of time from work, and, in fact, in any persistent menstrual disorder, medical advice should be secured. The disturbance of menstrual function may be due to easily remediable causes.

Perhaps the most common finding is under-development of the genital system. The so-called "infantile" uterus is usually due merely to delay in reaching full maturity, which may be expected to take place in time; but since endocrine glands afford the stimulation to its growth, sometimes treatment by gland extracts is indicated.

Surgical Treatment.

In some few cases dysmenorrhea is due to disease of the ovaries or the tubes, or to a defect in the uterus, or to appendicitis. In such cases, surgical treatment may offer immediate and permanent cure.

Leucorrhea.

This term is applied to a white or whitish discharge from the vagina. It may be accompanied by no symptoms and be more or less chronic, or it may come on suddenly with itching, burning and pain on micturition. The cause is likely to be infection, but the chronic sort may be due to pelvic congestion.

Leucorrhea should always be investigated. Usually it can be cured, although not by self-prescribed douches and the like. Such a discharge may be due to gonorrhea, but there are many other organisms that cause similar symptoms. Any infection of the vagina should be checked before it invades the other parts of the reproductive system.

b. Emission

In a general way, emission in the male is comparable to menstruation in the female, since it is a normal function and consists of the casting off of unused germ cells.

After puberty, sex cells are constantly being produced in the tubules of the testes, and being stored in the seminal vesicles. In the absence of marital relations, the seminal vesicles become overdistended at times, and they discharge automatically. Since this

process occurs during sleep it is called nocturnal emission. Sensory impulses from the erection and ejaculation may be vaguely or clearly experienced, often as part of a dream.

The frequency of emission varies according to the rate at which the seminal vesicles become distended. It may normally occur several times a week or not at all.

This normal and harmless function, which represents merely a passive overflow of accumulated secretion, is often represented by quack "doctors" as a great danger. They speak of "lost manhood," and even of serious diseases, as a possible result. Emission does not deprive the body of any substance it needs or can use, and does not weaken. However, if it occurs too frequently, a reputable physician should be consulted.

Other Discharges.

It is not normal to have any sort of discharge from the urethra except at micturition and ejaculation, and at micturition the fluid should be clear and should be passed without pain or smarting. Any departure from normal should be investigated, whether or not there has been any known exposure to venereal disease. Similarly, any soreness or swelling of any part of the genital organs should be investigated. There are several fairly common ailments that are insignificant at the start, but that should be cured before they progress.

Chapter 44

HEREDITY AND PARENTHOOD

In addition to life itself, parents give their offspring certain characteristics; they are solely responsible for what their children *inherit*, and largely responsible for the physical and psychological traits their children *acquire* from conception onward. Neither responsibility can be ignored in planning for parenthood. Both hereditary and congenital conditions will be discussed in this chapter.

A. HEREDITY

Many people are prevented, by false fears regarding heredity, from parenthood which would have been entirely justifiable, and others blindly become parents of children inevitably seriously handicapped by inheritance. It behooves each person, even before the question of marriage becomes imminent, to find out as much as he can about his forebears. If there is any question about his fitness for parenthood, he should consult a competent authority. The ancestry of the prospective mate should be similarly investigated, and the decision be made whether co-parenthood is scientifically justifiable—that is, whether the offspring will be likely to be normally equipped to meet the conditions of living. There are certain facts about inheritance that will influence any conscientious person who knows them.

Method of Inheritance.

The essential feature of sexual reproduction is the fusion of the nuclei of the ovum and the sperm. Each nucleus contains a definite number of chromosomes (twenty-four in man), each of which contains the *genes*. It is the genes that are the determiners of all the characteristics which the child inherits from his ancestors. The fertilized ovum from which the child develops thus contains twenty-four pairs of chromosomes, one member of each pair passed on through his father, the other member through his mother.

It should be noted that inheritance comes *through* the parents and not *from* them. The germ cells are among the first that are set aside in embryonic life. Thus the inheritance that any individual will pass on

to his offspring is determined before he is born. He passes on what he has received from an endless line of ancestors behind the parents.

Determiners (Genes).

Determiners in the germ cells settle certain matters about inheritance very definitely. There is only *one* possibility about the species to which offspring will belong; human beings are necessarily and hereditarily human beings. There are only *two* possibilities in regard to sex; people are hereditarily of one sex or the other. There is only one possibility regarding race in the case of a person whose ancestors were all of one pure racial group.

Beyond these three points, accurate predictions about inheritance are somewhat limited; for there are *countless varieties* within races, and any given person's ancestors are likely to have been widely different from each other, and to have passed on to their descendants innumerable possibilities. For example, it can safely be predicted that a person of the white race will not be of the same color and facial contour as one of another race; but it cannot be predicted that he will be blond or brunette unless it is known that on neither side are there any determiners for anything but blondness or brunetteness.

In some respects it can be known what sort of determiners a given person cannot help having and what sort he certainly has not; but in general these accurate statements can only be made about *unit characteristics*, and only in cases when *enough information* is available about the stock on both sides.

Unit Characteristics.

A unit characteristic is one for which there is a separate determiner (or gene) in the germplasm. It was Mendel, an Austrian monk, who in 1865 first grasped the facts that are now the basis of the principles of heredity. But his ideas did not become widespread until they were rediscovered independently by De Vries, Correns and Tschermak in 1900.

Mendel experimented with peas, and found that certain traits appeared, or did not appear, with mathematical regularity as a result of mating between plants of known ancestry. The laws later formulated by De Vries and others bear the name of Mendel, the first to discover them. They have been of the greatest use in plant and animal breeding, and in the study of human heredity.

Only one pair of genes, one from each parent, is necessary to cause a unit characteristic to appear in the offspring. In human beings it has been found that certain traits that distinguish races

from each other are unit characteristics. These are: (*a*) color of skin, and some of its other qualities; (*b*) color of hair and its form (curly, wavy, straight); and (*c*) color of eyes. The size and shape of the body as a whole, and the size and shape of facial bones and features are hereditary, but not as unit characteristics.

Certain *abnormalities of structure* are also hereditary as unit characteristics, among which may be mentioned:

a. Polydactylism (too many fingers or toes).
b. Brachydactylism (fingers or toes lacking one bone each, hence shorter).
c. Syndactylism (webbed fingers or toes).
d. Achondroplasia (general dwarfing).
e. Albinism (absence of pigment in skin, hair and eyes).
f. Myopia (near sightedness, one type only).

These abnormalities are in varying degree handicapping, but do not constitute actual disease.

Certain *diseases* are hereditary as such—that is, they will appear in a certain percentage of those who carry determiners for them. The list has grown shorter and shorter as more is known of the causes that act upon people during their lifetime, but it includes some conditions that are beyond question truly hereditary. Among them are certain nervous diseases, one form of blindness, color blindness, one form of deafness, hemophilia, and some forms of mental disease, including one form of feeblemindedness.

Transmission of Unit Characteristics.

One of the simplest illustrations of the Mendelian law is furnished through experiments in mating black animals with white animals. If two black animals that have had only black ancestors are mated, they will have only black offspring. Similarly, white animals with only white ancestors will have only white offspring. If the offspring of these two sets of parents are mated, they will all be black, but they will carry genes for white color in their germplasm. If two of these black animals with white determiners in their germplasm are mated, some of the offspring will be black and some will be white. Mendel discovered that the proportion is three black to one white. He also discovered that one of the three black animals will be pure black without any determiners for white, just as purely black as the black grandparent; that two will be black with white determiners, just as the parents were; and that one will

be purely white with no black determiners, just as the white grandparent was (1:2:1).

Unit traits of humans are transmitted in the same way; but they cannot often be predicted because it can seldom be certain just what genes are present, and what effect the presence of other

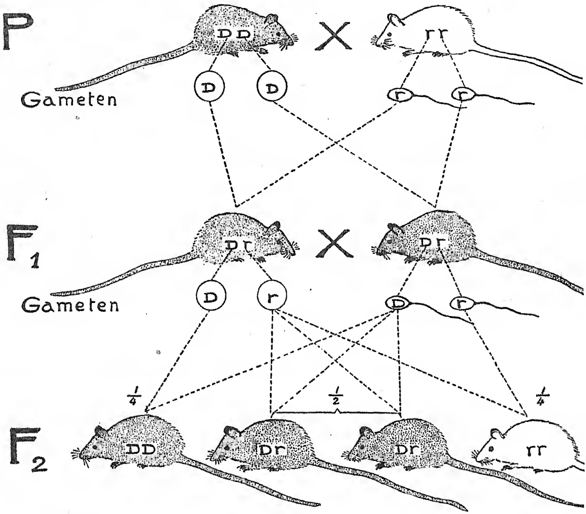


FIG. 175.—A diagrammatic representation of monohybridism. In the mouse, the characteristic "gray fur" is dominant (*D*) in contrast to the characteristic "albino," which is recessive (*r*). Note that all of the first generation (F_1) have the genetic constitution Dr and form two kinds of gametes. If two Dr individuals are crossed, their offspring (F_2) will be one-fourth pure *DD*; one-half hybrid *Dr*; and one-fourth pure *rr*. In color, three-fourths will be gray and one-fourth white. (Drawing by Anne-Marie DuBois. Courtesy of Ciba Symposia.)

genes will have in modifying the traits. Some things can be said with certainty, however. Two pure blue-eyed parents, all of whose ancestors were blue-eyed, cannot have brown-eyed children. Similarly, certain abnormalities and diseases are certain to appear in a given proportion of offspring of two parents who bear determiners for them. (The details regarding the inheritance of specific

characteristics are out of place in this volume, and the student is referred to the bibliography for further reading.)

Dominant and Recessive Traits.

A dominant trait is one that appears in preference to its opposite when genes for both are present. For example, brown eye color is dominant; it appears when one gene for it is present. Recessive means hidden. A recessive trait may not show even when determiners for it have been present. Nevertheless, some brown-eyed people are part blue-eyed, and have blue-eyed offspring. There is confusion about some of the various human hereditary traits because many of them are recessive. Those who do not show a trait themselves may be unaware of the fact that they nevertheless can transmit it. This is what is meant by the layman's term "skipping a generation."

Normality is as a rule a dominant trait. This means that if matings occur between those who are themselves normal, an undesirable trait that has been present in the family of one or the other is not likely to appear. Although it is not invariably so, the chances are in favor of normality when the stock shows a preponderance of normality. Defects (except the unit ones) tend to become less pronounced in children than in a parent if the other parent does not bear the defect. However, certain abnormal traits are themselves dominant; which furnishes the reason for the suggestion already made, to obtain expert advice regarding any question of inheritance.

Multiple Combinations of Genes.

The possibilities in the first two generations when dealing with traits due to one pair of genes are simple to reckon, but they become infinitely complex when it is a question of even as few as three pairs of genes. In trihybrids (individuals who are the product of the mating of animals varying in three respects) in the second generation of offspring the ratio is 27:9:9:9:3:3:3:1.

In man the genes for specific characteristics are carried in twenty-four pairs of chromosomes. If we consider but one pair of genes in each pair of chromosomes the number of possible combinations of these genes would be 2^{24} or 16,777,216. Each chromosome may carry a thousand or more genes. It is not surprising that no two individuals are alike, particularly when one considers that this stupendous figure becomes a quite unthinkable one when the possibilities in more than two generations are computed. In nine generations (or approximately three hundred years) a person has had

1022 ancestors including the parents, if there has been no intermarriage of relatives and thus no ancestor in common.

Among so many possibilities, it would be expected that chance would sometimes cause the genes to fall together in such a way as to *perpetuate resemblances* between people; and at other times to combine so as to bring about totally *new combinations* of genes, and thus to *create differences*. Therefore, except in respect to the traits hereditary *as such*, and except in cases where the chances, by all the laws of chance, favor a given trait, nothing can be counted upon.

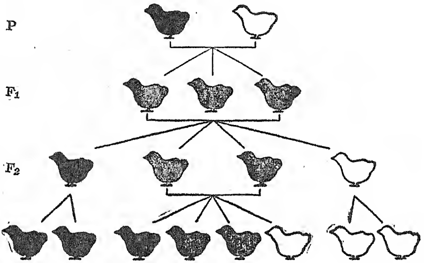


FIG. 176.—Diagram showing the course of color heredity in Andalusion fowl, in which one color does not completely dominate another. (Kellicott.)

Marriage of Cousins.

The wisdom of co-parenthood on the part of those who are nearly related to each other, as cousins, depends upon the sort of inheritance they have in common, and individually. If the heredity is known to be good on the side through which they are related, the offspring will have a double chance of a good inheritance. Conversely, they will have a double chance of a bad inheritance if the common stock is defective. Obviously, the precautions against perpetuating an undesirable trait should be just as strict in the case of any two people, whether relatives or not.

Physiological Inheritance.

Genes produce "unit" physiological effects as well as structural defects. They may cause individuals to vary not only in the way their bodies are built but in the way their organs do their work. The term physiological inheritance signifies the inherited tendency of the body or of certain organs or tissues to function in given ways or to react in given ways to certain stimuli.

One of the most obvious examples of poor physiological inheritance is that which causes hereditary baldness before senility in males. This is due to a gene which is dominant in the male and recessive in the female—that is, females carry the gene, but the trait hereditary baldness appears only in the male. Presumably obesity that "runs in families" is sometimes of the type due to genes, which causes an hereditary inability to deal with foods in such a way as to prevent them from depositing it as excess fat. It has already been mentioned that longevity is thought to be a physiological inheritance, and that a tendency to premature senility, with degeneration of heart, blood vessels and kidneys, may also be in some cases hereditary.

The physiological inheritance in many cases appears to be not so much a tendency on the part of single tissues or organs to perform poorly and to cause trouble, but a general lack of constitutional vigor. In some families there are many weaklings likely to react poorly to almost any sort of unfavorable conditions. On the other hand, some families almost uniformly produce those who are "sound in wind and limb." What is meant by the term "good constitution" is a good physiological inheritance. As has been stated, normality tends to be dominant, nevertheless certain genes for abnormality of function are dominant and will produce a given trait if present in the ancestral stock on both sides.

Although the physiological inheritance is inflexibly fixed, it is usually so within wide limits. It gives tendencies or susceptibilities or predispositions, but these can often be prevented from developing into real illness if a person knows what he has to combat and does so intelligently.

Mutation.

It has been implied that nothing changes the chromosomes, and that is very nearly the case. However, from time to time marked variations occur in a species, comprising traits that would seem not to be due to new combinations of genes, but to a real change in them. These are called mutations.

Nearly all recessive genes have been produced by mutation. Blue eye color, for example, is a mutation from brown. Brown eye color is due to pigmentation of the front and back of the iris. This is caused by a gene which may change by mutation to a gene which causes pigmentation only on the front of the iris. The eye will then appear blue. This gene for blue eyes may in turn mutate to a gene which produces no pigmentation at all, and the eye will appear red

(the condition in albinos) because the blood in the capillaries then becomes visible.

Ordinary variations do not repeat themselves in offspring, except by chance, but mutations, once they have appeared, are hereditary. Presumably they are due to chemical or physical changes in the genes during the lifetime of the one who bears them.

Blastophthoric Damage.

So far the discussion has concerned only true inheritance as determined by genes in chromosomes. The germ cell in each sex consists, however, of other material than chromatin, the rest of the cell being known as the *cytoplasm*. It is natural to suppose that the cytoplasm should be subject to damage from the same causes that damage other cells. It seems to be true, although it has not been proved in many definite respects, that such damage (known as blastophthoric damage) is a common cause of general weakness and of defects.

Among the conditions that affect the cytoplasm are the two poisons lead and alcohol, and the disease syphilis. Any of these causes may damage the sex cells so that conception does not take place, or so that the offspring are of feeble vitality, either mentally, or physically, or both. It should be noted that alcohol is most particularly likely to have this effect when present in the body of one or both of the parents at the time of conception. Also, it should be noted that the offspring of syphilitic parents may suffer harm even though they escape the infection itself by being born after the communicable stage is over. Direct radiation of the ovaries by X-rays is thought to cause similar damage and to weaken, if not to prevent, offspring.

Blastophthoric damage is *acquired* (i.e. does not involve the genes), but it may affect the second and subsequent generations. Three results are possible in the case of those whose germ cells are weakened by blastophthoric injury: (1) no offspring are born to them; (2) weak offspring are born who are unable to reproduce; (3) comparatively normal offspring are born, who in turn have entirely normal families if they mate wisely. In cases (1) and (2) the family dies out in a generation or two. In (3) the family survives, and there may even be increased resistance to the original injuring agent in the surviving offspring.

Acquired Characteristics.

It would not be true to say that the germplasm *cannot* be affected by its environment, but at least it can be asserted definitely that it

is not so affected by most of the things that happen to a person during his lifetime. For example, if a person falls down and breaks his nose and develops a hump in it, his children could not possibly inherit it. Similarly, if a child has meningitis early in life and the level of intelligence is thus impaired, the offspring will not inherit the defect; or if a person becomes mentally ill as the result of a circulatory disorder of the brain, his offspring need not fear that they will inherit mental disease. (On the other hand, a hump nose, low intelligence, and mental disease may each be hereditary rather than acquired.)

Special aptitudes are often suspected of being hereditary. Possibly this is so in respect to musical ability. In general, aptitudes are acquired by each generation, with, as a foundation, the requisite intelligence, neuro-muscular coordinating capacity, etc., all of which are a part of a person's total inheritance.

Pseudo-heredity.

Diseases that "run in families" laymen usually consider hereditary. Often individuals who have studied their family history are quite impressed and worried by the fact that a large number of the members of the family have died of the same disease—for example, of tuberculosis or heart disease. Before concluding that there is an hereditary tendency in that direction, it is desirable to find out whether the conditions were not purely acquired ones in each instance. It may be found that a family weakness exists in respect to the respiratory tract or the circulatory system, but another possible explanation is that *similar environmental conditions* and similar *habits of living* were responsible for all of the cases of the same disease in the family.

A family living closely together is likely to pass about some forms of disease (*a*) by *contagion.* This accounts, for example, for most cases of apparently hereditary tuberculosis. Those who live together are likely to have similar ailments (*b*) because they all live according to the *same customs.* For example, when gastrointestinal conditions affect many members of a given family, it may be because all of them have the same faulty dietary habits. Similarly, what seems like inheritance of a nervous disposition may often be due to the fact that parents who are nervous bring up their children in an environment and in a way that is likely to make them nervous, too.

Another cause of conditions that seem to run in families is (*c*) the *copying* of the parents' complaints by the children. Children

do this not necessarily consciously, but because they identify themselves so fully with their loved parent, or for some other psychological reason. Without knowledge of it, the child assumes the same aches and pains, which were perhaps real in the parent, but are often fictitious in the child. An individual who, unknown to himself, has done this, sometimes believes he has inherited the parent's ailment. One should always be a little suspicious of the validity of a symptom that exactly resembles one in a parent. Its cause in the two cases may be quite dissimilar.

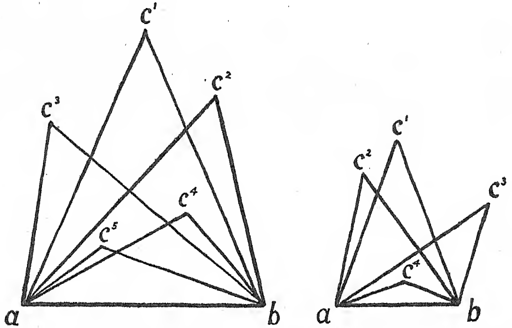


Fig. 177.—Diagrams to show the effect of environment and training in relation to heredity. The base of each triangle (*ab*) is the inheritance. The other two sides of the triangles are to represent environment (*ac*) and training (*bc*). The area of the triangle represents the phenotype. Note that the area depends upon the length of *each* line.

Genotype and Phenotype.

The term *genotype* is used to describe the hereditary make-up and all its potentialities. In some respects the potentialities are sharply limited and in other respects very wide. (E.g., a blue-eyed person cannot become a brown-eyed one, but a person with blond skin may tan and even become permanently darker.)

The term *phenotype* describes what an individual actually is at any given moment, when certain possibilities of the genotype have been realized through the effect of a multitude of environmental factors, which have been at work from the time of conception onward.

Obviously, although heredity establishes all *potentialities* it does not establish all *actualities*. All developments are only what the

original inheritance makes possible. The phenotype may be less, but it cannot be more, than the genotype permits. Probably no one ever reached his full hereditary capacity in all lines of development.

Development of the Phenotype.

The development of the phenotype may be illustrated by a triangle, using the genotype as a base. The two other sides of the triangle may be used to represent the two other great forces, environment and training, that determine the development of the individual on the basis of what he inherits. Even when inheritance is poor, good environment and training may enable an individual to be happy and useful in life. But with the best of heredity and a poor environment and training, he may fall short of what he might have been, in fact may be an utter failure. The diagram illustrates the way in which these two factors influence achievement, given an inheritance of equal potential value.

In regard to one's own success in life, quite apart from the possibility of becoming a parent, one's inheritance needs to be studied in order to know the particular sort of environment and training one should have in order to develop to the highest level. If a poor heredity is known or suspected, still more emphasis must be placed on the other factors that determine what one shall become. Certain sorts of inheritance may be quite overshadowed by proper training and care.

There is really no argument possible about the relative importance of heredity, environment, and training, although the question is constantly being raised.

Eugenics.

The science of eugenics deals with the subject of racial betterment through proper mating. It consists first of research into the nature of hereditary characteristics, by animal experimentation and by the study of human family trees. Second, it attempts to draw the public attention to the facts it has learned through research. Third, it stresses the fact that both racial welfare and individual welfare demand consideration of problems of heredity. Fourth, it attempts to prevent mating among those who have definitely recognizable characteristics that would be detrimental to the race's welfare. It is not to be hoped that society can ever rid itself of all its problems by the methods of eugenics. Nevertheless, both society and individuals should profit enormously by heeding all that the eugenists have to say as a result of their research.

Euthenics.

Euthenics might be called the science of *realizing hereditary possibilities* through the improvement of environment and through education and training of all sorts. It has its application both in the life of the *individual* and in the life of *society* as a whole.

Individuals can apply the principles of euthenics by fulfilling as many of their own possibilities as circumstances permit, so as to give their children an example of achievement, and the results of achievement (e.g., a good home, the advantages of education etc.), and, in general, by fitting themselves to become good parents, able to bring out the most that is possible in their children.

Pending a time, in the far future, when matings shall more often be such as to secure to the offspring a favorable inheritance, progress demands of each generation that whatever the inheritance of its individual members may be, their *realized achievement* be as high as possible.

B. PARENTHOOD

Fertility.

The degree of natural fertility (i.e., ability to produce offspring) varies somewhat. It is generally agreed that the age of greatest fertility for women is between the twentieth and the thirtieth year.

Whether from natural causes or otherwise, it appears that couples at the higher intellectual and social levels are less fertile than those at lower levels; at least, they have smaller families. It is reported that the present generation of college trained persons are not producing offspring enough to keep up their own numbers, to say nothing of increasing the population.

Only three out of every eight families are today contributing to America's growth of population by having three or more children. The few families having five or more children are contributing three-fourths of all our population growth. Childless marriages have increased until they are now about one out of every five. Whereas in 1800, every 100 new born girls would have had 223 daughters and 497 granddaughters, at present, with a greatly improved mortality rate, the original 100 would produce only their own number of daughters and granddaughters.

Physiologically, it is generally agreed that in the ordinary course of events a healthy wife of a healthy husband, if both are fairly young, will conceive within a year after marriage, and thereafter about every two years. That this does not often happen in exactly this way may be due to a number of different factors.

Failure of Conception.

Conception fails to take place for the following causes: (*a*) no germ cells are produced in one or the other of the partners, either because of immaturity or disease of the sex glands; (*b*) cells are produced that are short-lived; (*c*) there is a barrier somewhere along the route the cell must travel in either one partner or the other, which keeps it from reaching the other germ cell; (*d*) the secretions of either the male or the female tract are chemically unfavorable to the life of the germ cells; (*e*) the uterus is in a position that is unfavorable for the entrance of semen; (*f*) the mucous membrane lining the uterus is not a favorable resting place for the fertilized ovum, which is cast off; (*g*) there was no ovum in the tube at the time the spermatozoa arrived, ovulation not having recently taken place; (*h*) medical measures, either mechanical or chemical, have been used to keep the ovum and the spermatozoa apart.

Points (*a*) to (*f*) represent abnormalities; (*g*) represents the law of chance; (*h*) represents the avoiding of natural consequences. In regard to the latter point, it should be stated that such measures are sometimes necessary when pregnancy would be a danger, and that physicians are the ones to make the decision regarding the measures to be used. Unless so prescribed, they are likely to be unsafe or unsuccessful, or both.

Sterility is undoubtedly more often due to the results of the venereal diseases than to any other single abnormality. In either sex, the commonest abnormality that results therefrom and that causes sterility is the sealing of the ducts through which the germ cells should pass. This takes place as a result either of *swelling* caused by inflammation, or the healing of inflammation with the formation of *scar tissue* which has contracted.

It appears likely that diet is also involved in sterility. Among animals, lack of vitamin E in the diet seriously interferes with the ability to conceive and to bring offspring to term. That this vitamin is also of importance in human fertility is rather strongly suspected.

Preparation for Parenthood.

To become the parents of a normally formed and constituted child requires more than giving the child a good inheritance. To a considerable extent the anatomical and physiological soundness of a child depends upon the condition of the parents at the time of conception and of the mother from that time onward. Logically, those who are contemplating parenthood should learn in advance whether they are fit to become parents.

For obvious reasons, such foresight and care cannot be made matters of legislation, but must be left to individual discretion and conscience. In only one respect has it seemed feasible to pass any laws to limit the marriage of those not in condition to be parents; fourteen states have passed laws requiring individuals applying for marriage licenses to present certificates showing that they have been examined and found free of venereal disease.

In the states having such laws undoubtedly large numbers of individuals have been brought under treatment for venereal disease who otherwise would not have had such treatment and would have married while they were in condition to infect their offspring. But the benefit of these laws has extended to other states; the publicity that has been given to the passing of them, has called attention to the fact that parental health does influence child health, not only in respect to venereal disease but also in many other respects.

Whether or not one's state requires it, those about to marry should voluntarily have examination for venereal disease (which conceivably may be present even in those not aware of exposure and who have no symptoms). At the same time, it would be vastly to the advantage of the next generation if those about to marry were to have a general examination, which would reveal any other conditions that require treatment before parenthood is undertaken. A number of conditions which do not permanently stand in the way of parenthood may do so temporarily, and will constitute a hazard for mother or child or both if pregnancy is begun before the abnormal condition is improved or corrected. This is true, for example, of some forms of heart disorder, tuberculosis, diabetes, anemia, malnutrition, etc.

It might be added that premarital examinations, and the correction of any form of ill health, is also of value for other reasons than the effect upon offspring; the good health of both partners is in all ways a sound basis for happy and successful marriage and parenthood.

Prenatal Life.

Dr. E. J. Kempf has said "The noblest and most difficult art of all is rearing human thoroughbreds." Given the best of inheritance, the child needs also the best of nurture, from the moment of conception onward.

The fact that the miracle of creation so often does bring into the world healthy specimens of humanity should be set over against the

fact that vast numbers of infants before their birth suffer irremediable harm for which their parents are ignorantly or heedlessly responsible.

Although the process of growth is inherent in the fertilized ovum, and although growth will often take place in spite of many adverse factors, the fullest and most complete development of the infant to the time of birth can hardly take place unless much attention is given to the matter.

There are no reliable figures to indicate how many embryos fail of development in the early months and are lost through spontaneous abortion and miscarriage, but it has been estimated to be nearly one-third the number of live births. Undoubtedly still others occur unnoticed and unrecorded. Regarding still births, the records are more complete; it is reported that 75,000 infants annually develop until the time of birth but are born dead.

The nature of the difficulties in prenatal life are numerous. Presumably many an embryo has not the capacity within it to continue its development. But in many cases discoverable causes can be found for such feebleness. It is believed that a considerable number of early embryonic deaths and still births are due to preventable causes associated with the health of the mother. Their prevention is certainly to some extent a matter of maternal hygiene, and such reductions as have taken place or can take place in the rate of such prenatal accidents must be based upon the application of that theory.

The same is true of neonatal deaths—that is, the death of infants within a month of birth. The explanation of such deaths is usually prenatal damage causing faulty skeletal development or specific physiological disorders or general weakness. In Fig. 5 page 12 it was shown that the group of congenital malformations and diseases of early infancy are among the ten leading causes of death in the United States, regardless of age. Classed under the heading "diseases of early infancy" are those which are peculiar to that time of life, most of which originate before birth. It is reported that half the total number of infant deaths under one year of age occur in the first month, chiefly from faulty prenatal development.

Nevertheless, 95% of all babies born alive are healthy and normal, and nearly all of these should grow up satisfactorily if they have the proper care. To prevent the prenatal conditions that doom the other 5% to deformity or invalidism and early death, attention must be centered upon the health of the mother.

Maternal Functions.

During the prenatal life of her child, the mother's role is not simply that of providing it a place in which to grow. As has been mentioned, there is a constant interchange between the infant and the mother through the blood stream of each. There is no other way whereby the infant can obtain the materials it needs for growth than through the mother's blood, and scarcely any other way in which it can be injured.

Prenatal Damage.

A. Malnutrition.—If the mother is well nourished, the child is likely to be; if the mother's blood does not contain each and every substance the child needs, the child will to that degree be malnourished and fail to develop properly. The daily diet of the prospective mother is therefore of prime importance; it must be quantitatively sufficient, and, in particular, it must contain all the essential food factors that go to form the various structures of the developing child.

B. Poisons.—Just as nutriment passes to the child through the placenta, so also may poisons in the maternal blood. In certain industrial occupations damage to the unborn child by poisons (e.g., lead) is a major hazard. In other circumstances perhaps the greatest danger comes through self-medication—always a hazard, but especially so during pregnancy.

C. Infection.—Most bacteria do not pass the placenta. The embryo is therefore protected against certain infections. However, the infection that is perhaps the most serious of all for the child in utero, syphilis, is quite certain to be transmitted to the child if the mother is infected and does not have very complete treatment either before or during pregnancy. It is thought that the toxins from many kinds of bacteria, if not the bacteria themselves, often pass the placenta and affect the child, perhaps to such an extent as to cause its death. The expectant mother should avoid, for the child's sake as well as her own, any and all infections, and have them promptly and properly treated if they arise in spite of precautions.

D. Trauma.—As for mechanical injury of the mother as a cause of injury to the child, this may occur, but the child is well protected by the amniotic fluid in the sac that surrounds it, and is not likely to be injured as long as the sac remains intact. Nevertheless, extreme exertion and strain are to be avoided.

E. Fatigue.—In general, overfatigue of the mother is detrimental to both her and the child. In some states laws have been passed

making it illegal for pregnant women to be employed in industry for the last three months of pregnancy. In less taxing occupations it is frequently possible for those who are pregnant to carry on their activities about as usual during a normal pregnancy, with care to avoid too great fatigue.

F. "Marking."—The superstition still prevails that the mother can "mark" an unborn child by something she looks at, touches, hears, or thinks. This is entirely false; there is no mechanism whereby any "maternal impressions" could be transferred to the child, since its only contact with the mother is through the exchange of substances from the blood. Furthermore, birthmarks and the various developmental defects such as cleft palate and hare lip appear early in prenatal life, and were present before the supposed marking took place. Some are hereditary and others are acquired as a result of disease or malnutrition of the embryo.

It is unquestionably true, however, that the mother who is full of fears and apprehension is likely to derange her health in such a way as to affect her nutrition and that of her child; whereas the one who is confident and serene during pregnancy is improving the general situation for both. In this indirect way maternal impressions do have significance.

Prenatal Care.

The majority of intelligent women today have some sort of prenatal care; the diagnosis of pregnancy is usually self-made by the absence of the menstrual periods for two or three months, and the prospective mother in about 50% of cases in cities consults a physician at about the middle of pregnancy. It would be vastly preferable for both mother and child if the diagnosis of pregnancy were made by a physician as soon as it is suspected, and if the pregnant woman were under medical care throughout the entire period of gestation.

Among the less intelligent, the majority do not consult a physician until nearer the eighth month of pregnancy, which is too late for the physician to render the best service in protecting mother and child.

Prenatal care involves first a general examination, and then specific examinations that concern the pregnancy itself. The patient is instructed regarding the various matters of personal hygiene—not in a general way, but in specific ways appropriate to the condition of the individual in question. Examinations and instructions

continue during the pregnancy, the patient seeing the physician at the intervals he requests. In a pregnancy that is proceeding normally, the intervals will usually be once a month during the first six months, twice a month during the seventh and eight months, and once a week during the ninth month. The intervals will, of course, be more frequent, if any condition arises to call for it.

There are several rather common disorders of pregnancy that may be fatal if neglected. Among these may be mentioned a condition known as toxemia of pregnancy. It involves the kidneys, and is usually first shown in changes in the urine and in the blood pressure. Of the various other conditions which may endanger the life of the mother or the child or both, no comment need be made beyond stating that practically all of them give clear evidence to the physician, usually in time to avert them, and that they need cause no fears on the part of the prospective mother who is under competent medical care and reports to her physician strictly according to his instructions.

Competent medical care means either a general practitioner of medicine who has had large experience in obstetrics and whose work in this field is respected by his fellow physicians and leading individuals in the community, or an obstetrician, a specialist in obstetrics certified by the American Board of Specialists in Obstetrics and Gynecology. (The names of individuals are to be found in the *Directory of Specialists* or the *Directory of the American Medical Association*, both to be found in public libraries.)

The Hazards of Birth.

The process of birth is not ordinarily, and should not usually be, a particularly hazardous occasion for a child, and yet it may be so if prenatal care has not been satisfactory, and if the delivery is not skillfully managed. Even with the best of care, in some cases the mechanical conditions are such as to create difficulty. A great deal depends upon the comparative size of the child and the pelvic outlet of the mother. Also, the position of the child as it advances toward birth is of importance. A great many difficulties may be obviated by recognizing them in advance, by means of pelvic measurements, and other examinations, and by making suitable plans before emergencies arise. The public is familiar with some of the methods physicians use to overcome mechanical difficulties—cesarian operation, for example, whereby the child is delivered through an incision in the abdominal wall; and the use of instru-

ments for traction. A wide variety of manoeuvres is available to the skilled obstetrician, to bring the child into the world in spite of handicaps.

In the hands of a competent physician, little need be feared, provided the patient is willing to accept the physician's best judgment. Perhaps accidents more frequently occur in the case of women who demand that labor be shortened by the use of instruments, or that its pains be entirely obliterated by the use of anesthetics throughout.

It is reported that in 1936 there were 15,000 women delivered in this country with no assistance except that of members of the family and neighbors. Under such circumstances it is not surprising that birth accidents occur, but that they do not occur more often. Among the more common accidents are broken bones and torn nerves, especially of the arms, the latter causing paralysis. The facial nerve is also sometimes damaged, causing one-sided facial paralysis. The most serious accidents are those that involve injury to the skull, causing hemorrhage within it, and damage of the brain; the result may be paralysis, mental defect, or convulsions. Danger also arises in respect to breathing immediately after birth; often the child requires expert assistance in inflating the lungs for the first time and starting their automatic action. Obviously, the birth of a child, although a natural process, cannot safely be left entirely to nature.

The Mother at Childbirth.

All that has been said of the possible hazards to the child applies equally to the mother, for the same causes that endanger one endanger the other. However, the hazard to the mother is never as great as to the child. The maternal mortality rate is more or less regularly about 20% of infant mortality during the first month.

The maternal death rate in the United States was for many years higher than in most of the other countries reporting to the International Health Office, but in the past twenty-five years this matter has been of much concern to physicians and public health workers. Studies and work along this line were backed by assistance to the states from the Federal Government through the provisions of the Sheppard-Towner Act. The result has been that deaths from puerperal (childbirth) causes have greatly declined, as shown in Fig. 178.

The first decreases in the maternal death rate occurred in the middle of the last century when it was first discovered that puer-

peral fever, one of the most serious hazards of childbirth, was a contagious disease. In this country the credit for the discovery is usually given to Dr. Oliver Wendell Holmes, the poet-physician, who first announced it in the medical journals in 1843. However, the first clinical work in attacking the disease appears to have been done by Semmelweiss of the staff of the Vienna Hospital in 1846–7. The disease was extremely prevalent in those days. In one outbreak in Vienna, one mother in six died of it, and a total of 5,139 deaths occurred. Semmelweiss ordered that the hands of all those entering

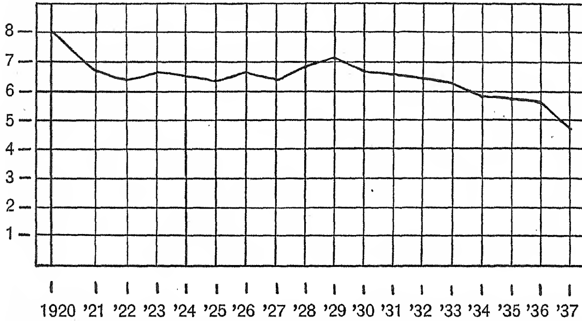


FIG. 178.—Decrease in the puerperal death rate per 1,000 live births in the United States from 1920 to 1937. (Data released by U. S. Bureau of Census, 1939.)

the delivery rooms be washed in a solution of chlorinated lime, and in a few months the death rate for mothers fell from 12.24% to 3.04%, and later to only a little over 1%. After the discovery of bacteria and the adoption of the aseptic technique for excluding all bacteria from hands, instruments and materials used in delivery rooms and operating rooms, the rate dropped still lower. In 1937 it was even less than 1%. Today, puerperal infection is much more common in connection with miscarriages than with normal deliveries at term.

Similar, although not so spectacular, decreases have also occurred in other complications of childbirth, such as hemorrhage. In fact, complications are comparatively rare today in those who have good care during and at childbirth.

The United States maternal mortality rate in 1937 was 48.9 per 10,000 live births. In twelve states the rate was less than 40, and in ten states more than 60. The range was from 25 in one state to 92 in another.

It is of interest to consider these figures in comparison with figures for the same year regarding births in hospitals. Throughout the country the average percentage of births in hospitals was 44.8. All but four of the states having average or better than average maternal deaths rates also had higher than average percentage of births in hospitals; and conversely, all but three of the states with the worst maternal mortality records had lower than average percentage of births in hospitals.

The average percentage of births in hospitals in four groups of states, grouped according to their maternal mortality rate was as follows:

Number of Maternal Deaths per 10,000 *live Births*	*Average Percentage of Births in Hospitals*
Under 40	55.8
40–49	50.3
50–59	34.8
60 or over	23.9

Similar correlations were noted regarding medical attention at delivery. In ten of the states with the best maternal mortality records, 97% or more of the births were attended by physicians, and in seven of the states with the worst records, only 72.5% or fewer of the births were attended by physicians.

In one state with a maternal mortality rate of 71, less than half the births were attended by physicians, and less than a tenth of the births took place in hospitals.

Although the correlation is far from perfect between hospital birth and low maternal mortality, it is close enough to suggest that the increased use of hospital facilities will make possible still further reductions in maternal mortality. The implication is not that childbirth cannot safely take place in homes; thousands of births do take place uneventfully in homes. But the average home, or even the best home, cannot be equipped as a hospital can to care for all the possible complications that may arise; and the lack of proper equipment may determine the outcome.

Saving Infant Lives.

During this century, and particularly in the past twenty-five years, much has been learned about the methods of caring for

infants, and has been widely applied, with the result that the infant death rate (deaths of infants under 1 year of age, per 1,000 born alive) has greatly decreased. The data for the past 90 years were shown in Fig. 8 page 15, and in that chapter it was noted that one of the chief reasons for the increased average length of life in this country is the advance that has been made in saving the lives of infants.

The specific causes of infant deaths in 1937 are listed in Fig. 179, the data for that year being contrasted with those for twenty years ago. It will be noted that in the past two decades there has been a

Causes of Infant Mortality

Cause	*Number of deaths of infants under 1 year, per 1,000 live births*	
	1937	1917
Premature birth	15.5	19.1
Bronchitis; bronchopneumonia	5.6	10.7
Congenital malformations	5.1	6.2
Injury at birth	4.9	4.0
Diarrhea; enteritis	4.1	20.0
Congenital debility	3.5	9.2
Influenza; pneumonia	3.0	11.5
Whooping cough	1.1	3.0
Syphilis	0.5	1.0
Tuberculosis	0.3	1.1
Diphtheria	0.1	0.5

Fig. 179.—Infant mortality, U.S.R.A. 1937 contrasted with 1917.

decline in the rate of every cause of infant deaths except injury at birth, but if data for the intervening years had been given they would have shown that that rate, too, has been steadily declining from a higher level in 1931. A study of these causes of death will indicate the nature of the measures that must be taken to bring about still further improvements.

Years ago it was thought that a high infant death rate was inevitable owing to the natural feebleness of the new born child. We now know that not many need be born feeble; nearly all can be born strong enough to survive, and with due care and protection will survive. There are some, even today, who argue against the effort to save infant lives, on the grounds that those who die in infancy are weaklings not worth saving. This argument is entirely

false; even the most vigorous infant, and the most promising, may die as quickly as a delicate one if, for example, it is not given the right food. Many a great man has been a "feeding problem" in infancy. It is reported that the parents of Enrico Caruso lost seventeen children in infancy before they succeeded in raising their eighteenth child, the greatest tenor of his time.

Today most communities consider it a matter of local pride to have a low infant death rate. In fact there is no more accurate index of a community's sense of social responsibility and its enlightenment in health matters than the efforts it makes on behalf of its infants. Certainly the money that communities or individuals spend to bring infants to healthy adult life could hardly be spent in any more valuable way.

PART 6

MENTAL HEALTH

Chapter 45

THE BRAIN

It is logical to begin the study of mental hygiene with the consideration of the health of the brain, since the brain is the center through which is mediated everything that goes to make up the conscious mental life. In it are centers for *sensations* from within the body and from the environment, and centers for all the sorts of *action* of which any part of the body or the individual as a whole is capable.

Mental life is founded upon an *organic biological basis*—the sensory-motor experience of the body—a substratum common to all living things. Upon that substratum is built, in humans, all the variety of conscious experience, including thought and emotion. The mental life depends fundamentally upon having a brain with certain characteristics of structure and corresponding possibilities of function.

Cerebral Development.

Insignificant as the brain appears in some creatures, nevertheless in each it represents its highest stage of development and the ultimate in its potential adaptation to its environment. Some sort of brain is present in all but the lowest forms of life.

The simplest of all organisms is hardly more than a formless and structureless bit of living protoplasm, which reacts in the simplest chemico-physical ways to its environment. Yet the beginnings of a sensory-motor apparatus are found even among the single cell organisms. Some of them have a definite spindle shape, with one end differentiated as the head end, possessing feelers whereby forward motion is guided.

Much higher in the scale of life, in the worms, the head end contains a simple sort of brain in which the senses of smell and taste are received, and from which go the nerve impulses activating the motor acts of approach and feeding. Still greater sensitiveness at the head end is present in fishes; in them, spots at the head end became sensitive to light, and other spots to pressure and movement (the primitive eyes and semicircular canals). In amphibians and

land animals there also developed at the head end certain areas sensitive to sound (the primitive ear). As each of these senses developed, the species became still better equipped for adaptation to environment.

The simplest sort of brain is in principle much the same as the most elaborate. In all vertebrates the nervous structure in embryonic life is first a thin plate of cells, then a lengthwise fold, then a tube. The head end of this tube expands and becomes the brain; the rest becomes the spinal cord. The expansion takes the form of three vesicles (the forebrain, midbrain and hindbrain), which soon become five.

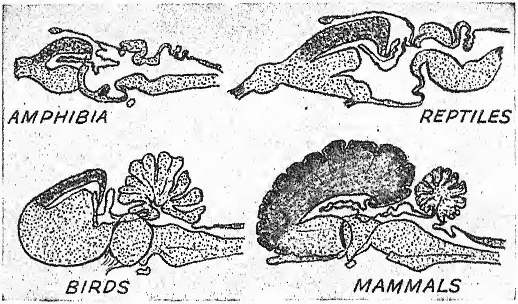


FIG. 180.—Vertical section of the brain of vertebrates, with corresponding portions of forebrain shaded. Progressive development is shown from amphibia, such as the frog, to mammals, such as the cat. Note convolutions of cortex in mammals.

The five cerebral vesicles in their most primitive forms are centers serving the following functions: the forebrain, the sense of smell; the interbrain, body sense; the midbrain, sight; the hindbrain, body balance and equilibrium; and the afterbrain, the vital processes such as breathing and beating of the heart.

In the higher forms of life the embryonic forebrain develops into the cerebral hemispheres, only a small part of which is concerned with the sense of smell. Also, the forebrain acquires a highly organized outer layer called the *cortex*. Below the level of the reptiles, the cells of the brain are merely clustered together in groups called nuclei. In reptiles there first appears in the forebrain a better arrangement; the cells form stratified layers, which makes for greater efficiency in the transfer of impulses.

In mammals, the forebrain has become the largest part of the brain, and has a thick cortex. In some, the cortex is comparatively smooth, but in others it has many *convolutions*, which greatly increase the surface area of the cortex and the number of nerve cells it can contain. Rats and rabbits belong to the former group, the lissencephalic; the dog, horse and elephant belong to the latter group, the gyrencephalic, and owe their superior mentality to the type of cortex. Adaptive responses such as are called intelligent are possible in proportion to the development of the cortex.

Wherever in the brain the nuclear arrangement of cells prevails, responses through that part of the brain are immediate and automatic; but through the cortex the response to stimuli may be delayed and of greater variety, and may be chosen with a view to suitability. In all creatures, cortical responses may be used as a check upon many of the nuclear responses. Whereas nuclear regulation of behavior is essential (e.g., in regulating the automatic beat of the heart), cortical regulation widens the possibilities of adaptation.

The Human Brain.

The human brain is equipped to carry on mental processes impossible for any other creatures. The forebrain with its elaborate

Animals and Man	*Encephalic index (per cent)*		
	Fore-brain	*Mid-brain*	*Hind-brain*
Fish	19.	43.	38.
Alligator	41.	25.	34.
Rabbit	68.	0.5	27.
Dog	72.5	0.5	27.
Gorilla	87.	0.5	12.5
Human (2 years old)	90.5	0.5	0.9

Fig. 181.—Comparative surface extent of the three cerebral vesicles. (Dr. Frederick Tilney.)

cortex, the *cerebral hemispheres*, constitutes a large proportion of the total brain structure. Just as it is the dominant part of the brain, so is it the dominating force in promoting man's adaptation to conditions of living. Man's superiority to the animals is shown in Fig. 181.

Cortical Activity.

As has been mentioned frequently in this volume, much activity is *reflex;* a stimulus is received and a response immediately occurs. The other sort of acts of which man is capable are *voluntary* acts. They are, in principle, not unlike the reflex. The chief difference is that voluntary action involves a spacing between incoming and outgoing nerve impulses. The spacing is *anatomical;* it involves the travelling of the nerve impulse over many association neurons in the cortex of the brain, where lie the centers of conscious perception and voluntary action. The spacing is also *functional;* it involves a selective process, whereby certain pathways of association are chosen in preference to others. This is the process called thinking. The cortex is where such thinking takes place.

The spacing between stimulus and cortical reaction may be short, in both senses of the term. For example, if the stimulus is a dime lying at one's feet on the sidewalk, the response may come immediately in the act of leaning over to pick it up. Such an act occurs so spontaneously and promptly that it can hardly be distinguished from a reflex. Much voluntary action is precisely of that nature. This is true of all acts that are impulsive; the impulse arises as a result of a simple stimulus, which travels over a short and direct path to the neurons that bring the response.

Impulsive responses are often conditioned ones, much like the conditioned reflexes already mentioned. As a result of past experience one may become predisposed to act in a given way in response to a given stimulus. Presumably all people are conditioned to pick up money lying on the sidewalk.

However, some acts appear to be in a somewhat different category. They appear to be not impulsive or reflex, but reasoned. For example, if the dime were lying in the mud, or the individual had a lame back, his reaction might be to let it lie there and walk onward. Ideas occurred in his conscious mind, and his response was to these ideas. In such a case, the stimulus of the dime was accompanied by many other stimuli (the mud, the feeling in his back, etc.) and numerous afferent pathways were activated. These in turn made synaptic contact with numerous association neurons, and revived past experiences. He recalled how unpleasant it is to have dirty hands or a pain in the back. While these various associations were being made he was performing the process known as thinking. When he finally directed the train of thought toward one outgoing channel, he was reaching a decision, and when he finally acted he was performing a consciously determined, or voluntary, act.

Such activity of the nervous system (called cerebral, or cortical) always involves a large number of association neurons in the cortex of the brain, and large numbers of afferent impulses received in the past together with those being received at the present. It is a characteristic of the cerebral cortex that the result of past impressions may be stored—that is, when a stimulus caused nerve impulses to pass over a given pathway once, the same stimulus is likely to cause impulses to pass over the same pathway again. This accounts for memory and recall. A mental process may be simply remembering—as, for example, in the case of a student reciting a lesson verbatim.

Sometimes, however, old and new impressions become associated in new ways, and a new concept results. This is known as imagination. It may take the form of creative thinking or original thought. From it spring art, literature, science and philosophy.

To do logical thinking, or reasoning, one may direct the train of thought so that it wanders among association neurons not idly but purposefully, not in a hit-or-miss fashion, but in order. This superior power of the human brain depends upon the larger number of neurons in the cerebral cortex; the kind and variety of association neurons that have been used in the past; the keenness of the sensory perceptions; and, finally, upon practice in directing the train of thought.

A. INTELLIGENCE

Definition.

The more highly developed the cortex of the brain the higher may be the level of intelligence. Intelligence is generally understood to mean the ability to learn, remember and reason. More specifically, intelligence may be said to be:

(*a*) the ability to profit by learning, not merely to learn;

(*b*) to correlate what is learned, so as to see relationships between cause and effect;

(*c*) to compare this with that so as to see differences and resemblances;

(*d*) to detect flaws;

(*e*) to appreciate values;

(*f*) to formulate theories and hypotheses, and ways of testing them;

(*g*) to assemble the evidence needed to solve problems—to bring the unknown into the realm of the known.

Briefly, intelligence involves the ability to deal with reality constructively and creatively, and to live adaptively.

Intelligence is not entirely a matter of the cortex. It may not be present in those whose cortex is so constituted as to permit it. Nevertheless, it cannot be present without a cortex of specified type and condition.

Tests of Intelligence.

Until this century there was no other method of assessing an individual's intelligence than observing his verbal and motor responses in various life situations. This method is often highly satisfactory, for adaptation to life situations is the most genuine test of intelligence.

However, in childhood the individual does not always disclose his native capacity unequivocally. Charles Darwin, for example, was considered by his teachers to be distinctly below average in mentality. A great man of the present day was balked at every turn in his educational career because he found it quite impossible to learn to spell. He was thought to be "lacking"—and so he was, in spelling ability, but not in intelligence. His defect was a small one in one of the word centers in the brain, which did not affect the greater part of the cortex.

The need for other than personal judgments in the case of children led psychologists to devise *formal mental tests*. By testing large numbers of children of different ages, norms have been established; these are stated in terms of *mental age*. A child would have a mental age of 10 if he passed the 10-year tests. If his chronological age were 10 he would be judged to have normal mentality.

The *intelligence quotient* is the mental age divided by the chronological age. If a child of 10 passed the 12-year tests, his I.Q. would be 1.2 or, as more commonly stated, 120 (the number 1.2 carried to two points to the right of the decimal and the decimal point omitted). By technical methods the results of nearly all mental tests may be stated in terms of mental age and intelligence quotient.

The same tests may be used for adults, but beyond the age of 16, the chronological age is still stated as 16. Intellectual ability beyond that age level would therefore show, in tests of general intelligence, as a higher I.Q. Specific tests are, however, available for measuring adult capacities.

In groups it is often of value to rate individuals according to their relative standing in the group, each individual having a rank in one or another decile (tenth) of the group.

Mental tests do not take into account the emotional and environmental factors that may prevent a person from scoring as well

as he might under other conditions; but neither do the informal tests of life situations. Repeated tests by various methods usually give consistent results, and these usually correspond to the individual's customary responses in every-day life.

Lack of Intelligence.

The term feeblemindedness is used to describe levels of intelligence below normal range. These levels may be specified in terms of I.Q. or mental age, or by the terms (*a*) dull normal; (*b*) moron, mental age from 7–12 years; (*c*) imbecile, mental age from 2–7 years; and (*d*) idiot, below the level of 2 years. However, it is hardly justifiable to compare defectives with normal children at any age, for the mental performance of defectives differs in quality from that of those who are simply immature.

Feeblemindedness may be either hereditary or acquired. The lesser degrees are more often hereditary and the greater degrees acquired. When hereditary, feeblemindedness is a recessive trait—that is, an individual who is not himself feebleminded may transmit it to his children if he and his partner lack the genes for normal-mindedness. (See Fig. 175.)

The causes of acquired feeblemindedness are numerous. During prenatal life, or at any time before full development of the brain has occurred, disease or injury of the brain may delay or prevent mental growth. Among the infections, congenital syphilis is of major importance.

Mental deficiency is obviously a problem of preventive medicine, since many cases occur unnecessarily. As for cure, the prognosis is not good except in a few types (e.g., cretins, whose mental defect and general condition is due to lack of sufficient thyroid secretion). For the most part, the solution is in the field of special education, to develop whatever powers the feebleminded may have; often they may be fitted to earn a living. Institutional care is usually required for those below the mental age of 7, and for the higher grade defectives if their defect leads to asocial behavior.

B. MENTAL ACHIEVEMENT

The amount of brain work a person can do, and the quality of it, depend upon one factor that cannot be changed and upon many factors that can be changed. The immutable factor is, of course, the inherited number and quality of brain cells. There are limits beyond which a person cannot go in mental achievement, but these limits are probably never reached.

Favorable Physiological Conditions.

Given a brain of good hereditary structure, which has attained full development, and has remained structurally sound (free from the harmful effects of injury or disease), the ability to carry on the process of thinking and to do it well requires, first, that the brain be kept in "good running order."

The brain being part of a biological unit, the body, its capacity to work well depends to a large extent upon how well the rest of the body works. It is generally agreed that, to obtain the best service from one's cerebral neurons, health is a decided advantage. That has probably been the case, for example, with the members of the National Academy of Science, 150 of the most learned men of the country; they were examined by their fellow member Hrdlicka, anthropologist of the Smithsonian Institution, who found them "living proof that the most brilliant brains are usually found in the huskiest bodies." The same was probably also true of a large series of graduate students in one of the colleges; 99% of those with an I.Q. over 140 (the genius class) were in good health.

A multitude of physical factors are of significance in determining whether an individual is able to make good use of good brains. Two are of special importance in every-day life.

A. Good Cerebral Circulation.—Hrdlicka has suggested that man has the inherent brain capacity to think from ten to a hundred times more effectively than he does now, and that "with a rich blood supply and no waste matter cluttering the cells a man might be mentally above all life's perplexities."

To have a thoroughly good circulation it is necessary for most people to activate it daily by a reasonable amount of exercise. In a series of 119 honor students, only 9% limited themselves to required exercise, and the highest academic honors were in several cases won by those who also won highest athletic honors.

However, beyond the amount necessary to keep circulation active, additional exercise may not be as profitable as additional rest or additional study.

The brain worker will usually find it an advantage to take one period of suitable exercise daily and to interrupt work for a moment or two every hour or so to stir up his circulation. The latter exercise periods should not be long enough to disturb "mental set." After brain work, similar light exercise is suitable before going to bed.

B. Optimal Nutrition.—No matter how good the circulation of blood to the brain, if the blood does not contain nutritive materials

such as the brain needs it cannot function properly. To nourish the brain cells it is not necessary to take any special foods (e.g., fish), but merely to take a correct amount of a balanced diet.

As for quantity, the brain worker will need scarcely more food than he would require if he were sitting still doing nothing. Brain work does not increase the metabolism by more than 3–4%. Benedict, one of the foremost students of nutrition, said "The cloistered scholar at his books may be surprised to learn that the extra calories needed for one hour of intense mental effort would be completely met by the eating of one oyster cracker or one-half of a salted peanut."

Clinically it is evident that if a faulty diet (or other causes) lowers the percentage of sugar in the blood the brain is impaired in its function. Lack of ability to concentrate, restlessness, lapses of memory, irritability and emotional instability appear, together with physical feelings of weakness and fatigue. The brain uses glucose; the blood coming from the brain contains less sugar than that going to the brain. It also produces lactic acid, which is removed by oxidation in the brain. These facts suggest that it would be wise for the brain worker not to be too long without food.

Qualitative aspects of diet are also important for the brain worker. It has been shown that vitamin B_1 is as important for the cerebral neurons as for other nerve tissue. A due supply of the various amino acids and minerals and possibly of the other vitamins is also essential.

Favorable Emotional Conditions.

Emotional attitudes are of importance in determining the level of intellectual achievement. Within the mind itself there must be an impetus toward such achievement.

It is probable that individuals vary as much in the wish or the will to use their available brain power as in the amount available by heredity. However, there seems to be less variation in the degree of motivation among those of high I.Q.; usually they do desire to use their brains to the full. It appears that superior quality of brain may carry with it an increased "drive" to use it. But whatever the degree of intelligence, it is certain that emotional factors may inhibit responses at the cortical level, or, on the other hand, may stimulate them.

The important matter of motivation will not be further discussed at this point, as it is the subject of the concluding chapters of this volume.

Conditions for Study.

Although individuals differ somewhat in the working conditions they find favorable for mental efficiency, most would agree that they do their best work when the following conditions prevail.

1. Vision is good, with or without glasses.
2. Lighting, whether natural or artificial, is adequate.
3. Position of the body is easy and uncramped, permitting full expansion of the lungs and favoring free circulation.
4. Temperature of the room is approximately 70° F.
5. Air in the room is in slight but scarcely perceptible motion, and kept free of smoke.
6. Body is free of discomfort due to ill health.
7. Fatigue is not marked.
8. Digestive tract is neither too full nor too empty.
9. Genuine interest in work exists or can be aroused.
10. Emotional calm exists or can be established.

To this list of conditions many persons would add another—quiet. When this is important, it is one of the most important of all.

Another requirement for some is freedom from interruption for long periods. They find the relative proportion of work done in one long interval may be much greater than in an equal length of time in short intervals. However, most good students cultivate the habit of immediate concentration and learn to make good use of any available time.

If an individual finds it difficult to concentrate on brain work and to accomplish it, and if all the conditions mentioned above are correct, a disorder of health might be suspected and sought. More often than not, the cause can readily be found and corrected. The same is true of psychological difficulties that stand in the way of putting a good brain to good use.

C. THE BRAIN AND MENTAL HEALTH

The brain is dependent upon receptors to bring it the "material" for cerebral processes of thought. Disconnected from the rest of the nervous system, the cerebrum would be as futile as a telephone exchange with no wires entering or leaving it. And this is true even though the brain does generate energy and does initiate impulses.

In turn, the whole nervous system is a unit in the larger whole, the body. Cerebral function is interrelated with every part of the body, and the actual content of the mind is in large part the product of sensory impressions from the body and its activities.

Finally, the human organism does not live in a vacuum but in an environment of persons and things, acts and events. Therefore interrelationships with the world outside itself affects every part of the body and every mental process, directly or indirectly.

Any consideration of mental health must take into account the widespread foundation of the mental life—which is a product of the *nervous system*, of the *entire body*, and of the *entire environment*. Obviously, the mental life is modifiable in countless ways.

Nevertheless, the *cerebrum* occupies a strategic position in mental life. If it is too much injured, life itself stops; if it is less seriously injured the mind may be proportionately injured.

Brain Damage.

Injury of the brain does not always cause mental disease. According to the location of a lesion, numerous cerebral functions

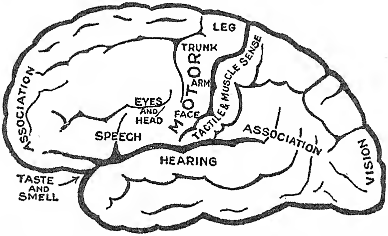


FIG. 182.—The localization of functions in the left cerebral cortex. (Winton and Bayliss.)

may be disturbed. Lesions of the motor area lead to paralysis of skeletal muscles, or to convulsions (spasmodic contraction of muscles, as in the disease epilepsy). In the various sensory areas, corresponding senses will be impaired or destroyed. It is injury of the cortex, especially of the frontal lobe, that is most likely to affect the mind.

Localization of some of the cerebral centers are shown in Fig. 182. These have been mapped out by laboratory research, and by clinical observations verifiable by surgical operations, X-rays, electrical tests, or post mortem examinations.

Examination of the Brain.

Disorder of the brain is diagnosed by examination of the entire body. Of special importance is examination of the various sensa-

tions; the motor apparatus; the sensory-motor reflexes; the organ reflexes; and the mental processes.

A new method of examination of the brain has been made possible through the discovery that the human brain generates electrical potentials which can be detected through skull and scalp. Although amounting to only 50/1,000,000ths of a volt, these *brain waves* that originate in the cortex may be amplified and recorded on photographic film or as ink tracings on moving ticker tape. There are two typical rhythms, with variations according to the individual and according to the condition of the cerebral cortex in respect to physiologic and psychologic states. Typical variations in the encephalogram have been observed in certain pathological states (e.g., in epilepsy and some forms of mental disease).

Brain Disease and Mental Disease.

A large proportion of mental disease is due to infection. Bacteria may cause encephalitis (inflammation of the brain) and meningitis (inflammation of the meninges), either of which may affect the mind. Syphilis is the commonest bacterial cause of mental disease.

Also, the brain may be injured by physical force; by chemicals (such as alcohol and narcotics); and by tissue changes originating within the body (such as cerebral degeneration due to senility or to arteriosclerosis).

Any alteration of the body affects the mind, in greater or lesser degree. Sir Joseph Barcroft, a Nobel prize winner, stated that "Man is an organic whole, so nicely adjusted that it takes very little to throw him off his physiological balance." He said this after he had made experiments in chilling himself by lying naked in an icy room. After a time his mental attitude changed; his desire to be up and doing became one of complacency. As he stated, "*Physiological liberties may not be taken without affecting the mind.*"

These statements are of special interest in view of the fact that no cause has yet been discovered for two of the mental diseases that are the most common. It may be that they have no single cause, but represent a variety of derangements of bodily function affecting brain function.

Psychosis.

The term psychosis means mental illness. Illness of the mind implies its lack of capacity to fill its role of adaptation. The term *insane* is a legal one; it is applied to the mentally ill who require custodial care and whose condition warrants their commitment by the courts to a mental hospital.

The manifestations of psychosis are in the sphere of (*a*) the intellect, (*b*) the mood or emotions, and (*c*) the content of thought. Behavior is correspondingly affected.

(*a*) *Intelligence* is often somewhat impaired, as shown in weakening of memory or ability to concentrate, or confusion about time, location and persons. In some cases dementia occurs, a form of feeblemindedness which represents loss of mentality from a previously higher level. In several types of mental disease, intellectual ability remains the same, although the capacity to use it is reduced; the mind may be thoroughly disordered without affecting the intelligence quotient.

(*b*) Frequently, if not always, the *affective* or *feeling* aspect of the mental life is altered. The mood may be elation or depression, so intense and persistent as to dominate life. Sometimes the mood is of apathy or deficiency of feeling; or the emotions may be inappropriate to the situation, minor matters arousing as much emotion as important ones. Other emotions that may prevail are irritability, anxiety, anger, and silliness.

(*c*) In another type of mental disease, it is chiefly the *content of thought* that is altered. It may contain material that is not based upon reality. The patient may hold a belief that is contrary to all demonstrable evidence—as, for example, that he is a candidate for the presidency. Such false beliefs are known as delusions. Or he may have false sensory impressions, as of sight or sound, not originating in anything in the environment visible or audible to others. These are called hallucinations. Some normal persons have experienced these phenomena, perhaps during an illness with fever, or in the half-waking half-sleeping state.

In general, a psychosis causes profound changes in the personality and the individual becomes "not himself." To the normal his ideas, feelings and behavior seem "strange" and "unreasonable." However, the abnormalities are often not at all conspicuous, especially when intelligence is not impaired. Often the person who is mentally ill is himself aware of it. He should, of course, place himself in expert hands for treatment.

Organic and Functional Psychoses.

When due to demonstrable physical causes affecting the brain, a psychosis is called organic. When no such cause can be discovered, a psychosis is called functional, the implication being that, so far as can be determined, only the function, and not the structure, of the brain is disturbed.

Heredity of Mental Disease.

Obviously, mental disease due to brain damage acquired during the lifetime will not be passed on to the offspring. Some of the functional mental diseases do, however, tend to "run in families." It is believed that they are hereditary in the sense that individuals in families having this type of mental disease are predisposed to it.

However, these psychoses appear clinically very much like a simple exaggeration of *bad mental habits* such as occur in lesser degree in many of those classed as normal. For example, the suspiciousness that characterizes one of these psychoses is ordinary suspiciousness greatly magnified. Therefore it is believed that early training in mental hygiene might prevent these bad habits from becoming so intensified as to derange the mind. Certainly every advantage of such training should be given to the child who may be susceptible to mental disease because of heredity.

There is also the possibility that the functional mental diseases will be found to have *physical causes*. For example, the depression of mental disease is very much like that which any normal person may feel at times of great fatigue or illness. Possibly the more profound and lasting depressions are similarly related to disordered body chemistry or bacterial toxins or the like. That some cases of functional mental disease may be cured through medical means lends support to this theory.

Prevention and Cure of Mental Disease.

Prevention of mental disease is highly important, since 47% of all hospital beds in the United States are now occupied by mental patients and the number is constantly increasing. Methods of prevention are according to the causes, as stated.

Cure is possible in a considerable number of cases of mental disease. Many are acute illnesses, from which recovery tends to take place under proper treatment; and even those of a chronic nature may sometimes be helped if treated early.

D. NERVOUS DISORDERS

The term nervous disease is properly applied to any sort of disease of any part of the nervous system. However, the term is used in another sense; the adjective nervous is applied to disorder of other parts of the body when dependent upon disordered nerve impulses. For example, the term nervous indigestion means that the function of digestion is poorly performed because the motor and secretory nerves to the digestive tract are misbehaving. In nervous

diseases of organs, the organs involved are sound and could work well if nerve impulses to them were correct.

Causes of Nervous Disorders.

When the regulating system of nerves does not properly regulate it may be (*a*) because *nervous tissue is not in good condition*, from such causes as overfatigue, the effect of chemicals, bacterial toxins, poor circulation, or shortage of calcium or of vitamin B_1 in the diet. Or (*b*) faulty regulation of an organ's activity may be due to *reflex disturbance* of its nerves by disturbance elsewhere, as, for example, the nausea and vomiting in seasickness, due to reflex impulses from the apparatus of equilibrium, or the same symptoms associated with dysmenorrhea or with eyestrain. Or (*c*) disorder of nerve impulses to organs may be the result of disturbing emotional states, as when nausea accompanies fear or worry. Although nausea has been used as the only illustration, virtually every symptom to which man is subject may be due to imperfect regulation of functions by nerves.

The layman is likely to think of nervous diseases as imaginary or "all in your mind," but this is a mistake. Even when they arise from a disturbed state of mind they are not imaginary; the motor and secretory disturbances of nervous disease are demonstrable by the same tests as those of organic disease. The effect upon the sensory nerves is equally genuine; the pain and discomfort really exist.

In some cases, the connection between emotions and physical conditions is perfectly obvious (e.g., fainting upon hearing bad news); but in all other cases, it is *unsafe to conclude that ailments are due to emotional states until every possible bodily cause has been investigated and excluded.*

Neurosis.

A nervous disease that is wholly or partly on an emotional basis is called a neurosis (adjective, neurotic). Physical symptoms that arise from mental states are called *psychogenic* (*psych*, mind; *gen*, produced by).

The term neurotic is in common use among the public as a term of opprobrium. The impression is that no one need be neurotic unless he perversely chooses to be. There is some truth in this concept, for the neurotic often could, if he chose, achieve a better emotional condition, either by his own efforts or with professional help. He is ill, however, and cannot usually cure himself by will power. Cure must usually be sought through a readjustment of his attitudes—toward himself, his environment and the persons in it. The necessary adjustments may be minor ones, but often they involve the whole personality.

"Nervousness."

The condition popularly called "nervousness" or "jitters" may be due to any of the causes already mentioned. To the extent that it is of psychogenic origin it is neurotic. However, it is frequently of physical origin entirely. It often appears, for example, in those who are overfatigued or who have lost much sleep. Also, it is often associated with depleting illnesses. It is always present with hypersecretion of the thyroid gland.

The difficulty in general irritability of the nervous system may be lowered resistance at synapses (see page 58). Apparently a number of conditions make it either easier or harder for impulses to pass from one nerve cell to another across a synapse. When the nerves are over-responsive, and the individual "nervous" or "strung up," it may be because stimuli pass too readily—that is, the threshhold at synapses is low. Possibly a chemical material mediating the nerve impulse at synapses is at fault.

Neurasthenia.

One of the more serious neurotic manifestations is neurasthenia. Nervousness takes the form of general weakness and lack of endurance, which is felt especially when interest is not aroused (selective fatigue). It is accompanied by numerous physical and mental symptoms. What the layman calls a "nervous breakdown" is usually either this neurosis or a psychosis. In about half of the cases physical causes can be found, and in the others the cause appears to be wholly mental.

Psychosomatic and Psychogenic Disorders.

As indicated, many of the neurotic disorders are partly physical and partly mental, both as to their cause and their symptoms. These are called *psychosomatic* (*psych*, mind; *soma*, body). They are far more prevalent than frank mental disease, and in the aggregate undoubtedly cause as much suffering.

The psychogenic component of these disorders is usually a poor response to the difficulties of life. Conflicting desires and tendencies create problems the individual is unable to face or to solve, although the problems and difficulties may be no greater than others can meet in adequate fashion.

There is some question whether there is constitutional inadequacy in those who become neurotic. The fact that cure is possible seems to indicate that this personality make-up is acquired rather than inherited.

A discussion of mental conflicts follows in the next chapter.

Chapter 46

PRINCIPLES OF MENTAL HYGIENE

Aim of Mental Hygiene.

Everyone is entitled not only to live but to have a life. That is what mental hygiene aims to make possible. With a sound body, capable of living fully, it is the mental state that determines what the actual content of life is—whether it is agreeable and valuable, to the individual and to others, or whether it is a source of misery and futility.

Health of Body and Health of Mind.

Fitness of the body, valuable as it is, does not ensure mental health. The phrase "a healthy mind in a healthy body" is a misleading one. The confusion has arisen because people notice that illness affects the state of mind (e.g., the pessimism and irritability of the weary are proverbial; the complacent after-dinner mood is taken as a matter of course); and that the state of mind affects the health (e.g., worry may cause indigestion).

What people do not so often notice is that even in a short space of time, while the health remains exactly the same, the mood may swing from exaltation through the whole gamut to depression, or the behavior from that of a saint to that of an imp. Furthermore the effect of illness upon the mind is an individual one (e.g., one person becomes "snappish"; another "grouchy"; another teary), which reflects only traits already potentially present. What illness does is not to *cause* personality defects, but to *intensify* them. Feeling ill is usually a poor excuse for behaving ill, or for losing one's perspective on life.

Those who are grievously afflicted in body may have excellent mental health; and those in superb physical condition may be mental wrecks. Obviously, the state of mind varies for reasons apart from health. Whatever the state of bodily health, the maintenance of mental health is a technique by itself. The mind is related to the body much as music is related to a musical instrument; the same instrument played skilfully gives forth finer music than when played by an amateur.

Intelligence and Mental Health.

It is sometimes thought that all that is necessary for a successful and happy life is a high level of intelligence; but that is not the case. To be sure, intelligence helps—just as physical health helps; but it is not a prerequisite nor a guarantee of stability or soundness of mind.

A man of great brilliance, retaining the full power of his intellect, may become quite irrational; he may, for example, be sure that he has a million dollars, when he actually has not a cent. He wishes he had a million dollars, and "the wish is the father of the thought." Similarly, a man may have "brains," using them cleverly about important matters, and yet he may be a misfit and unhappy.

Not infrequently a student in college is of the highest rank academically and the lowest rank in popular esteem; and one of scarcely average brains may endear himself to students and faculty alike and make a genuine place of honor for himself.

Obviously something besides brains is a determining factor in personality or mental health. Obviously, the P.Q. (personality quotient) is as important as the I.Q. (intelligence quotient). To discover what determines the personality quotient, it is necessary to consider the mind itself and its function.

The Mind.

For the purpose of discussing mental health, what the mind *does* is of more importance than what it *is*. What it does is to direct the behavior of the personality-as-a-whole. It is its motivating force. Any motive is, by definition, a *moving force*, i.e., it impels to action. Its impelling power is due to the fact that it feels like a wish. There is desire to act upon it, because there is *unrest* before it is acted upon and *satisfaction* thereafter. These two feelings in varying degree and quality precede, accompany and follow the realization of motives (or, in other words, the granting of wishes).

Briefly, then, the mind may be defined as the *sum of all the motives that cause an organism to act and all the feelings and emotions that surround these motives.*

Function of the Mind.

Biology shows that at any level of organic life there are motives. All organisms have things they have to do. In the simpler forms of life the motives come from the whole body and are merely chemical and physical reactions to the environment, whereby the organism is enabled to meet the hazards of the world outside it and thus to survive for its limited lifetime and to perpetuate its kind. These simple adaptive mechanisms become more complicated as the scale of life

rises and the organism becomes more intricate; but the main biological motives remain the same. Even in man they are the same. The purpose of man's mind is like that of all minds, *adaptation to the conditions of living.*

In man, not only the fundamental motives but also the possibilities of feeling have become extraordinarily elaborated. Essentially this provides man with a better means of coping with that which would defeat his biological purposes, but it also makes his mental life more complex. The very intricacy of man's mental make-up, the multiplicity of his motives and of the ways he can act upon them, gives him a chance for dismal failure or for brilliant success. This is what makes the game of life so interesting.

Conscious and Unconscious Mental Activity.

Some of the motives that govern behavior are clearly conscious and spring from reason; one is aware of them, and feels definitely as though he had had a part in originating them. Some motives are, however, only vaguely conscious, if at all. In some such cases one is aware of the impulse, and also of the feeling that goes with it (in scientific terms, the *affect*), but may find them mysterious and foreign to the conscious mind. In other cases, nothing is noted except the emotional reverberation of the motive as it is either acted upon or not, and one may be at a loss to account for the emotion.

Most people would readily grant that some of their trends do not spring from reason, and even run counter to it (e.g., an impulse to take alcoholic beverages, or to quarrel with one's brother). Upon the basis of common everyday observation it is fitting, then, to use the terms *conscious* and *unconscious* to describe impelling forces or motives. If motives are mental activity, and if mental activity is the work of the mind, it follows that there is a conscious and an unconscious mind. The former is what is commonly meant when the term mind is used; the latter needs further discussion, because it is a concept that underlies much of the mental hygiene of the present day.

The Unconscious Mind.

The unconscious mind comprises all the unconscious motives and the feelings that surround them. It consists, *first,* of the various trends toward action that characterize all human beings alike, and that may thus be called *native* or *racial trends.* Other names by which they are commonly called are unconscious urges, "drives," impulses, wishes, or desires; instincts; manifestations of vital energy,

or of elan vital (Bergson), or of libido (Freud). By whatever name they are called, the implication is that they are *inborn tendencies* to respond to stimuli after the fashion of mankind in general. So universal are these tendencies that if a human being ever lacked them he would be an object of wonder to his fellow beings.

It should be noted that these terms do not imply that all people do react alike to the same stimuli, but that the unconscious impulses at their root are alike. What each person *actually does* in response to these inner drives is an individual matter, the discussion of which forms the bulk of this chapter.

Second, the unconscious mind includes *personal trends*, that arise from individual experience, and that, for one reason or another are no longer conscious, but that color life and may modify the response to either conscious or unconscious motives. These are known as *complexes.*

Both instincts and complexes can be physiologically explained as *conditioned reflexes* or behavior patterns that are dependent, first, upon the intrinsic nature of man, and, second, upon the stimuli that provoke the intrinsically possible responses. The terms instinct and complex should always be used with due recognition of their anatomical and physiological setting.

Major Trends.

Three major trends that are universally observable in all human beings are associated with the three major relationships of life; (*a*) the self in relation to itself; (*b*) the self in relation to the mate or to sex; (*c*) the self in relation to other selves or to society in general. It has already been noted that the first two of these trends are observable even in organisms of the lowest grade; the third begins to be noted in higher animals, but is of the greatest significance in man. All of these trends have tremendous power; all may be acted upon in countless ways; all are in action all the time in all people in one way or another.

A fourth major trend is that of using the conscious mind. It is just as *natural* for a man to think and then to act accordingly, as it is for him to act upon impulse, but it is not as *likely* that he will do so, for this major trend is a more recent addition to man's equipment, and is not universally as powerful as the more ingrained motives. The characteristic function of the conscious mind is to note the conditions of living, and to take into consideration the matter of the *expediency* and the *social utility* of behavior. It tends to keep one from acting unwisely upon impulse, and to cause one to

make deliberate attempts to adapt to life in ways that will be good for each and good for all. It tends to be an *integrating force*, that keeps all one's impulses in harmony with each other, not overthrowing instinct, but, on the contrary, helping instincts to be gratified in *suitable* ways.

The Goal; Euphoria.

What human beings *want* in life is *euphoria*, or a sense of well-being, an indefinable sense that all is as it should be. It is the feeling that comes with wishes granted, problems solved. It is the reward for acting according to any of the major trends.

What human beings *do not want* is the opposite feeling, or *dysphoria*, which represents wishes thwarted.

Both euphoria and dysphoria may exist in varying degree and quality. For example, euphoria may range from simple content, a feeling of calm satisfaction, to the most ecstatic joy; and dysphoria may range from simple unrest to rage, sorrow, bitter disappointment.

The goal throughout life is to rid one's self of all forms of dysphoria, and to make euphoria as complete and constant as possible.

Mental Health.

At this point it will be clear that mental health is a matter of motives and emotions. Mental health may be defined as a state in which the mind is serving its purpose of adaptation to the conditions of living—that is, is acting upon motives *suitably* and thereby gaining euphoria.

The person who is mentally well, or has an adapted personality, is one whose conscious mind is used to face facts—all that he confronts; as a result of which he can meet all sorts of situations with equanimity and a suitable response, can get along smoothly with all sorts of people; has abundant dynamic power; and uses his powers in some sort of significant work, that squares with his own standards and those of the more civilized of his fellow beings. All of his forces will be pulling together in accord with the general movement of humankind toward higher levels.

Lack of Mental Health.

By contrast, those who lack mental health will be misfits, in one way or another—dragged hither and yon by their impulses and emotions. They will be likely not to do good work, and not to be happy, or if they are happy it will be at the expense of their own or others' welfare. Usually they can neither get along with them-

selves nor with others, nor meet situations (of some sorts or all sorts) effectively.

Some people get very far astray in their failure in adaptation, and become frankly mentally ill. Probably not a few cases of mental breakdown are due to persistent faulty adaptation, rather than to brain disease. But whereas serious mental disease is a remote danger for most, lesser malfunctions are extremely common, although they are not often recognized as such. Some of those whose mental health is not good are known as "odd," "eccentric," or "peculiar." Others are sometimes called "temperamental"; indeed they may apply the term to themselves, more as a compliment than as an apology, believing that their traits are the mark of a delicately constituted person as opposed to a "clod," and not recognizing that such traits reflect at all upon their mental health or that they account for their failures.

Even among those who get along as average human beings, however, there is usually much room for improvement. A person should be interested, for example, in any fault that keeps him more or less at odds with *other people*, of one sort or many or all sorts; for example, a tendency to be timid and reticent, to seek solitude, to be suspicious, to lie, to lack fairness and sportsmanship, to depend too much upon others, to dislike those of the opposite sex, to be oversensitive to others' opinions, etc.

Equally important are the traits that interfere with adaptation to *situations:* for example, procrastination; lack of promptness; beginning tasks and not finishing them; lack of absorbing interest in work; shirking responsibility; extravagance with money; inability to decide things promptly and to hold a straight course toward the goal; etc.

Finally, attention should be given to any persistently or frequently disturbed *mood.* One who is "strung up," "nervous," irritable, or gloomy, anxious, afraid (of something in particular or of many things), or who has perhaps a general feeling of discontent or unrest, should not feel that he necessarily has to go on bearing such a state of mind.

Personality Quotient.

If mental health could be measured and rated according to some such methods as intellectual powers are measured and rated, the person having good mental health would be rated as having a high personality quotient; and those lacking mental health, a proportionately lower personality quotient, according to the degree of lack.

It is, however difficult to establish scales of values for rating the personality, although psychologists have made attempts to do so. One difficulty arises from the fact that the adaptive value of certain traits is in relation to the whole individual. A trait that might be seriously hampering to one person might be of great help to another. For example, a tendency to be "dreamy" might be essential to a poet but detrimental in the extreme to a traffic policeman or a surgeon or a salesman.

However, some traits are always adaptive (for example, the ability to get along with others) and some never (for example, suspiciousness). It is these traits that must be considered in assessing the personality. But another difficulty arises in assessing even these; they do not have proportional value. For example, a person might conceivably attain a ranking of 97%, and lack only one trait rated at 3%; yet the lack of that particular trait might totally unfit him for adjusting to life. In other words, virtually all traits of personality may, in given instances, have 100% value.

Obviously mathematics is not of much use in assessing mental health. Although rating scales have a certain value, the rating an individual attains on such a scale may not correspond at all to the state of mental health as diagnosed by a psychiatrist, and as demonstrated in actual living.

Possibilities of Improvement.

The prospect for improving the personality depends, first, upon knowing when it needs improvement, and, second, upon realizing that it often can be improved. In the presence of any of the faulty traits or moods mentioned, it is not constructive to accept the common notion that "personalities are born, not made"—that some are born to be happy, successful, socially at east, etc. and that others are not, and that the less well endowed must simply make the best of it. A more constructive assumption is that undesirable traits of personality are to a large extent acquired traits; and that, conversely, to a large extent they may be corrected, provided suitable methods are used. This assumption seems warranted by the available data from the science of genetics, psychology and psychiatry.

Quackery.

The new knowledge of the mind that has been obtained in recent years and made public by psychologists and psychiatrists has made a great popular appeal. Everybody seems to be, quite

naturally, interested in personality matters. This interest has been capitalized in an entirely commercial way by many quack "psychologists," who have no claims whatever to the title. The public has been mulcted of millions of dollars for books, pamphlets, correspondence courses and series of lectures on "Psychology," "Will Power," "Personality," "Success," "Happiness," etc. These matters are too vital to accept advice about them from irresponsible persons.

Scientific Methods.

Everyone should understand that there are scientifically approved methods of approaching personality problems, and should utilize these methods even for what may seem like minor difficulties that a little will power should overcome. The cause of many faulty traits and uncomfortable moods may be mysterious to those who possess them, but often both the cause and the remedy will be clear to those who have made a special study of these matters and have had experience in dealing with them. *Psychiatrists* are physicians whose special interest is the human mind and human behavior. Often the best and the quickest method of improving the personality and the mental health is to confide fully in a psychiatrist.

Self-help.

In many cases a person who really wishes to do so can accomplish much for himself without professional assistance, either entirely by himself or with the aid of friends who are older and wiser. In general, it is not of much use for young people to talk things over with those of the same age. Possibly it might be a help to the shut-in type of personality to unburden his heart to almost anybody, but the "psyching" of each other that is so popular in colleges is usually a futile self-indulgence—and may be a danger, especially to those who particularly enjoy it. Often it is on a plane no higher than village gossip.

In attempting to help one's self the first step is to assess the personality. To this end, a certain amount of self-study by the method of introspection is needed. If carried to an extreme, introspection is not a good habit, but there is no harm whatever—in fact it is essential—to take stock of one's self from time to time and to estimate the personality quotient.

In so doing, the relative value of one's various traits to one's inward state of mind and outward adaptation should be noted. Often people balance a poor trait against a good one (e.g. lack of tact against kindly intentions) and feel that the personality quotient

remains high because the two balance, but that is not the case. As has been shown, a small defect may detract not a small amount from the personality quotient, but a very large amount; in fact it may make it a minus quantity, even though countless good traits are also present.

As a means of self-help, both in solving present problems and preventing future ones, it is of advantage to know what sorts of difficulties other people experience. Therefore, in the following pages will be presented some of the types of difficulties that commonly underlie faulty personality. They have already been suggested in a general way, but it is necessary to go into detail about the way in which motives conflict with each other, the way in which they are often unconsciously acted upon, and the solution of such problems.

Mental Conflict.

If the mind provided only very definite specific impulses toward adaptation, these could be followed just as they happened to be aroused and all would be well. There would be no personality problems—indeed, no personality. But the demands of instinct are not specific. There are countless ways of acting upon each of them. Also, since one of the major trends is toward the use of the conscious mind to solve problems, conflict may arise between any of the instinctive motives and any of the conscious ones. This multiplicity of possible courses of action naturally leads to the possibility, indeed the inevitability, of inner unrest.

Many of man's conflicts go on quite unknown to him, or he is only vaguely aware of them. What he is aware of in such cases is the feeling that he is drawn this way and that, as one motive or the other dominates. For example, the impulse to go forth into the world and do battle with it may conflict with the impulse to remain safe and protected in the family circle. Or the wish to be held in high esteem may conflict with an impulse to do that which would lower one's social standing. Sometimes the whole conflict appears to be between two thoroughly recognized warring claimants of the field and the victory—as when one wishes for wealth, and yet is drawn toward a career in which the rewards are not pecuniary. In most conflicts at least some of the motivating force is partly unconscious, which is the reason that they are both distressing and also difficult to overcome.

Conflicts between motives are abhorrent to the personality. They create inner tension or turmoil (depression, excitement, fear,

anxiety, worry, etc.) that demands that a solution be found. For this reason they will usually be solved in one way or another, but in some circumstances they persist more or less continuously and are at the root of many of the common disorders of the mind.

Solution of Conflict.

There are two possible *methods* of solution; first, a choice may be made between two motives, and then one of them be acted upon and the other denied; or a compromise may be made between them. Furthermore, there are two possible *agencies* whereby these methods are used; the conscious and the unconscious mind.

It is important to appreciate these four possibilities, for it is upon the *method of solving inner conflicts* that adaptation to living depends. The ideal solution is by means of open and above-board recognition of all the motives and all the realities involved, and then the making of choices or of compromises. Whatever renunciation is necessary it will not be of a motive but of a *way of realizing it* (e.g., the ideal solution of the wish to be admired would be to become admirable rather than pretend to be so).

A *consciously determined* course of action should permit all the fundamental motives to act, but in a fashion that meets the needs of the situation, that is completely adaptive, satisfies one's self, and satisfies humanity's best standards. When such a solution is reached, all the energies are available to be applied to the realization of the goals that have been approved.

On the contrary, *unconscious* solutions are more likely to be harmful than helpful, for they are emotionally determined. The unconscious choices or compromises are made solely to end conflict, banish tension, give satisfaction—regardless of the value of the solution for purposes of adaptation. Unconscious solutions sometimes happen to be good ones, but to be on a sound basis a person must "know what he is about." Unconscious solutions will be discussed first, and then conscious.

UNCONSCIOUS SOLUTIONS

Mental Mechanisms.

In observing what people commonly do in the presence of strong unconscious trends, it has been noted that certain compromises, of a dozen or more types, are often made. They are called mental mechanisms because they often occur unwittingly in mechanical fashion, in much the same way that reflex muscular movements take place. Just as the muscles automatically become tense in one

part and relax in another to keep one from falling over an object lying in one's path, and thus secure bodily equilibrium, so the mind executes manoeuvres in comparable psychic situations, to *protect* a person or *defend* him or *compensate* him in some way for what would otherwise hurt him psychically. Psychic hurts come about through denial of wishes; therefore these mechanisms represent *wish-fulfilment.*

Everyone uses these common mental mechanisms every day—sometimes to the advantage of his mental health, but more often not. There are some people who have good mental health without having given attention to the matter—those whom the world looks upon as "naturally" of good disposition, fine personality, upright character and sound mental health. The explanation may be that their unconscious mental mechanisms have brought about a good adaptation.

On the other hand, the unconscious mechanisms may bring about exactly the opposite result, even to the extent of causing a completely faulty adaptation. Therefore it is necessary to be acquainted with the mechanisms that commonly act unconsciously, so that one may be on guard against being victimized by them.

It will be seen that some of the unconscious mechanisms almost always need to be checked or redirected, but that several of them may be trained to be of great value.

Rationalizing.

When a person uses his conscious thinking powers, he thinks he is *reasoning*, but there is always the possibility that he is *rationalizing* instead. The two processes seem exactly alike, since each involves thoughts and ideas; yet they are vastly different.

Reasoning deals with known facts. It is the best method of coming in touch with reality and of adapting to it. Rationalizing consists of thinking to order, the orders coming from the emotions—one thinks what one feels like thinking. Everyone wishes to think himself intelligent, sensible, moral; therefore he does think so, by the process of rationalizing. He "thinks up" arguments to assure himself that he is *right.* When a person is rationalizing, his conscious mind is used at the behest of his unconscious mind to keep him from becoming aware of and ashamed of weaknesses of one sort or another.

A. Justification of Opinions: Prejudice.—One of man's favorite conceits is that he is above all else a reasoning, thinking being, and that all his opinions and decisions are made by pure logic. He does not like to feel that his emotions control him. Therefore,

whatever opinions a man holds, even though they be merely hand-me-downs from his various "bell-wethers," he defends as if they were the product of his own painstaking search for the truth.

On many matters, opinions are held by those who are not entitled to them. The only ground for an opinion on a given matter is sufficient knowledge of that matter; yet the average individual holds, or can produce, emotionally determined opinions on almost any matter that is presented to him. He "knows" this and that because it would not be emotionally comfortable to him to know anything else. It would disturb him, for example, to find any flaw in the opinions acquired early in life; it would reflect upon his wisdom in the past if he should change his mind. It might "unsettle" him if he ran the risk of acquiring new opinions. Furthermore, the mere acquiring of sound opinions would cause him a great deal of work; it is easier for him to be sure he already knows. Finally, it would be embarrassing to him to admit that there is anything about which he has formed no opinion. Seneca said, "Many men had been without question wise, had they not had an opinion that they had attained to perfection of knowledge already, even before they had gone half way."

The prejudiced often confirm their belief that their opinions are sound by going through the motions of listening to new evidence. It is often part of their rationalization to consider themselves open-minded. Also, to complete their feeling of rightness, they must be sure that those who hold opposite opinions are wrong. In fact, the tendency to attack the intelligence, even the good faith, of an opponent, often betrays the "biased" partisan. Those who reason have as deep feelings as those who rationalize, but they are not aroused to the same type of fiery defense of themselves or intolerant offence against others.

B. Justification of Folly.—Whatever a man does, even though governed entirely by his feelings, he is likely to account for it as the sequence of his mature deliberation.

Everybody does something or other every day of his life that is not entirely reasonable, but rather than admit unreasonableness, most people search out a comfortable argument to convince themselves that what they feel like doing, plan to do, or have done, is evidence of sound judgment. For example, a man who has been given a diet and fails to follow it, reassures himself by saying that the doctor did not "guess right" about what foods would agree with him, or that breaking over once in a while could not make any

difference, or that he could not embarrass his hostess by refusing the food served him, etc., etc.

C. Justification of Wrongdoing.—Ethical standards are so ingrained that most adults would be uncomfortable or even profoundly distressed if they had to admit doing anything wrong according to their code. Therefore they convince themselves that whatever they do is still according to their principles. They may tinker with their code, and make it elastic enough to permit what they really know it does not permit, or they may adhere to the strictest interpretation of the code—the "letter of the law"—and yet somehow succeed in making their faulty behavior fit into it.

The man who steals, for example, must feel that he was right in doing so, or his punishment at the hands of his own personality would be more severe than his punishment by the courts. He therefore clears himself in his own mind by some such rationalized belief as that the world owes him a living, or that rich men are fair prey, or that the one from whom he steals has no more right than he has to the thing stolen. Having done what he wished to do, he is able to make himself feel that he behaved both rationally and justly. Similarly, a girl who signs the registrar's name in validation of a railroad ticket may feel quite blameless if she can rationalize to the effect that if she had gone to the registrar, the registrar would have signed it, and that she merely saved both of them a little trouble.

The popularity of the phrase "what a person doesn't know, won't hurt him" is evidence of the wide use of this mental mechanism by the deceitful to ward off loss of self-respect.

Forgetting.

It is quite certain that forgetting is not always merely chance, but in many cases is an unconscious protective mechanism, in order to free the individual at the same time not only of responsibility but even of any consideration of conflicting motives. For example, if duty bids a man do one thing and pleasure bids him do another thing, he may quite unwittingly forget the unpleasant task. Or, a person may repeatedly forget the name of someone who reminds him of his own shortcomings, or someone whom he dislikes and unconsciously would like to insult.

Sometimes forgetting amounts to a complete obliteration of a past unpleasant experience (repression). Usually this is harmful. "Forget it" is not always good advice, although the phrase is

usually used to mean "don't brood over it," and that is certainly in accord with mental hygiene.

Emotionalism.

With all strong motives and emotions man has the tendency to give external evidence of what is going on within. It is instinctive to draw the facial muscles upward in a smile or laugh when pleased, and to draw them downward in a frown, a scowl, or a woe-begone look when displeased. The whole appearance and behavior may be altered as a result of emotion. Often the response of one's associates is colored by one's display of emotion. They may be attracted to the person who appears happy, and repelled by one under the sway of the uglier emotions. Those of kindly disposition may feel sorry for the down-hearted; those who are timid may be cowed by the angry; those who love peace may yield anything to a person who makes a scene.

According to the persons with whom one has to deal, one may unconsciously utilize emotional display to bring about certain responses. In other words, the unconscious mind often uses the signs of emotion for the purpose of wish-fulfilment. Children quite unconsciously cry for what they want. Adults may do the same, or in other ways use emotional display to gain their ends. To "make a fuss" of some sort may seem like the best solution of a problem (e.g., the man who flies into a rage, expecting to make people quail before him and be glad to secure peace at his price). A martyred look has secured many people many things; but sometimes not what they wanted. Adults should realize that even if they do not have "temper tantrums" they may still be using emotionalism in less transparent ways to accomplish that for which a worthier instrument would be more effective.

The mechanism of emotionalism may be used also as a means of gaining self-satisfaction. Many people luxuriate in emotions and are even pleased with themselves for being able to feel deeply the unpleasant emotions (e.g., righteous indignation).

Since it is only by means of the emotions that motives become activating forces, emotions are of the greatest value, and those capable of deep feeling are respected because of what their feeling gives them power to do (e.g. compose music, be loyal friends, wage campaigns, etc.). Naturally enough, feelings themselves become respected, and there are those whose unconscious minds mislead them into thinking they have reacted suitably to a situation when they have merely had strong feelings about it. What the "thrill-

seekers" do is to allow a motive to move them just to the point of keen emotion, and then to check the motive and luxuriate in the emotion. Many of those who are, for example, "moved by compassion" withhold their compassion from expression in any acts of kindness, but wallow in soft-heartedness. If they do take action at all it will be along lines that intensify their feelings still more (e.g., indiscriminate alms, which is for the sake of the giver, not the receiver).

We have coined the verb *to emote*, which means to be emotional or exhibit emotion in unsuitable ways and degrees. Much emoting is of the two sorts mentioned—a means of bending others to one's will, or a self-indulgence. Sometimes it gratifies other wishes (e.g. temper may be to relieve anger at one's self; loud laughter and giggling may be to attract attention; tears to arouse sympathy). Often, undoubtedly, emotional display has no great significance except as it indicates an individual's lack of good breeding.

On the other hand, unfortunate as is the habit of emoting, it is perhaps even more unfortunate for one's mental health if one feels obliged to hide all signs of emotion, and can never come out of one's shell of reserve. There is a happy medium.

Conversion.

This term implies the gratification of a wish through physical illness. A person who is ill cannot be expected to do the same things that a well person does; he can excuse himself for many acts left unperformed and can expect others to excuse him. Instead of blame, he may even receive sympathy and signs of affection. Therefore, it is not surprising that illnesses sometimes represent wish fulfilment. Headaches, indigestion, this and that symptom, may feel like the real thing, but be of psychic origin, not physical. In such cases they are rooted in an unconscious wish to make *impossible* that which one finds disagreeable. Illness of this sort is known as *hysterical.*

Hysterical illness occurred very frequently in the first World War and was called "shell shock." Soldiers became paralyzed or blind or afflicted with some other ailment that made it necessary to send them back from the fighting lines. They were not consciously shamming; but were yielding to the sway of their unconscious wishes, which demanded safety at any price. The situation may be exactly the same in everyday life (e.g. in those who suffer feelings of unfitness when confronted by the disagreeable reality of an examination or a term paper).

Some people through life gratify their wishes through ill health. The wish may be to gain the tender protective attention such as

parents lavish on a sick child, or to have an effortless life, or to punish the ones who are inconvenienced by the illness, or to account for one's failures—any of a number of wishes. These illnesses are not *imagined*. Those who are so afflicted bring their troubles on themselves, but not voluntarily; and they cannot be cured of them by will power—only by finding better solutions for their conflicts. The services of a psychiatrist are almost always needed in such cases.

Projection.

Projection is a means of preserving self-love by externalizing that which is troublesome within, or would be if admitted—that is, attributing the fault to something or somebody else. Parents sometimes cultivate this tendency in young children, who, however, are naturally much inclined toward it. For example, if a child falls down and bumps its knees the mother may say "naughty sidewalk," in order not to let the child have any feeling of self-blame for awkwardness. The same child at an older age, if he plays a poor set of tennis, may throw away his racket in disgust, not at it or at others, as he thinks, but, unconsciously, at himself; or if he is not pleased with his part in an interview he bangs the door as he goes out, unconsciously exhibiting the disgust with himself that he will not admit. If he faced his own shortcomings, tennis rackets and doors would not have to stand in his place to take the brunt of emphatic disapproval.

Projection becomes a very harmful mechanism when it involves externalizing one's faults and failures by ascribing them to *other people*. Unfortunately this habit is extremely common. First, it rids a person of self-blame. Second, it gives him a chance to despise somebody else as he would have to despise himself if he admitted his fault. Third, it makes him feel not only blameless but positively virtuous if he can show how much he detests that particular fault. For example, a person who constantly interrupts others in conversation, may accuse everybody of interrupting him, and say that if there is anything he cannot stand it is people who interrupt. Those who are the most suspicious of immorality of various kinds in others may themselves be strongly tempted, if not actually at fault, in the same ways. Those whom we criticize and censure most violently may be those who represent ourselves at our worst. For example, a dishonest person finds dishonesty all around him: he says "You can't trust anybody," or if he does not say it he may show that he feels it.

Not only one's general traits of personality, but the responsibility for specific errors of omission or commission may be side-stepped through the mechanism of projection. In popular parlance this is known as "passing the buck." For example, failure at a given task is humiliating if admitted; therefore not many people, even in this supposedly frank generation, will frankly admit it to *themselves* when they fail. It is more comfortable to think somebody else is to blame, and this they unconsciously persuade themselves is the case. One who flunks a college course, for example, may, by the mechanism of projection, assure himself that the instructor was incompetent, not himself.

One who is inclined to blame others falls easily into the habit of thinking others are deliberately standing in his way, maliciously opposing him, and trying to harm him. This is what is known as a *paranoid* trend. When carried to an extreme it constitutes a mental disease known as paranoia, in which the characteristic symptom is delusions of being persecuted. Those who believe that others "have it in for them," or who are inclined to feel abused, should realize that they are using one of the most dangerous of the mental mechanisms, which insidiously establishes most unfortunate behavior patterns.

Identification.

This mechanism consists of unconsciously establishing a sense of oneness with another. It begins early in life as identification of children with parents. Later, other heroes and heroines are chosen. When complete, it causes a person to feel as if he were the other and to share what the other feels. Sometimes it also includes emulation, or molding one's self after the other as a model. This mechanism is one that leads on the one hand to the highest traits of human beings, and on the other hand to some of the worst.

In everyday life, identification often occurs in the form of hero-worship. This may or may not be desirable. If the spirit of emulation is aroused, and the model is a good one, it is likely to be a constructive element in one's life. But the choice of a model is often made quite unconsciously, and on other grounds than that the model is one deserving of imitation. For example, a person may be so fully identified with a parent that the very weaknesses of the parent are unconsciously reproduced (e.g., the mother's timidity, or the father's fiery temper). Not only the wish behind identification, but even the fact of identification may be unsuspected. For example, many women who dress "out of character" have no idea

that they feel akin to those they copy or that any other manner of life than their own appeals to them.

Identification may be destructive rather than constructive when it is so complete as to cause a person actually to feel as if he himself were what the hero is and had accomplished what the hero has, and consequently to cease to be much interested in his real life or to make efforts on his own behalf. This type of identification is usually made by those who wish to feel great but wish to avoid the hard work of becoming heroes themselves. In extreme cases, a person may even be unable to differentiate his own personality from that of the hero, and may believe incontrovertibly that he is, for example, Julius Caesar, Napoleon, or Henry Ford; this is known as delusion.

At its best, identification is responsible for the feeling of empathy, or the ability to comprehend in other people even that which is foreign to our own make-up; and sympathy, or the tendency to be drawn toward others whom we unconsciously feel to be like ourselves or to have problems like our own. Identification may well be considered the root of altruism. Those who see all other people as other selves and are guided by that concept, can hardly fail to live generous, socially useful lives. This mechanism is tacitly recommended in the Golden Rule, "Do unto others as you would they should do unto you."

Phantasy.

One of the commonest compromise mechanisms consists of using the imagination to gratify wishes. This is both natural and normal in childhood, when the power to deal directly with reality is limited; but it may persist—to those who are "grown up" the imaginary world still may seem very real, and they may find it difficult not only to cease to "make believe" but even to recognize when they are making believe.

The tendency to phantasy is likely to arise when real situations become too unpleasant, or when real achievement in the satisfaction of any of one's wishes seems too difficult. Refusing to contemplate the actual facts, the individual ceases to live in the world of here and now, and takes up his abode instead in castles in the air. His dream land is peopled with individuals not at all like those he knows, but always kind, considerate, appreciative. Life is luxurious, easy, satisfying. He himself is not like his real self, but is gifted, noble, successful, admired. Time may change from the present to the past or the future; the scene may shift from the familiar to that

which is wholly imaginary; people may be real people idealized or perfect creatures such as are born only of dreams. Since all their wishes come true, those who depart thus from reality are happy, no matter how at variance their dreams are from the facts. "I dreamt I dwelt in marble halls" is to them more satisfactory than troublesome contact with realities that seem to them tawdry and depressing, or that demand too much of them.

Phantasy often takes the form of a perpetual series of temporary identifications with heroes of books, plays, and moving pictures, or even with those who figure in the newspapers. Some people live their lives almost entirely vicariously in the lives of others, and find it a satisfactory substitute for personal experience and personal joy in life. Rather than live their own lives, they prefer to identify themselves with those who do what they themselves would like to do if they had courage enough, or if they felt powerful enough, or charming enough—or if their conscience would consent, for it may be the villain rather than the hero with whom identification takes place; it is not only the flighty who glory in the adventures of highwaymen and "vamps."

Fancy often plays havoc with life. It does so when it makes one discontented with the real, and when it proves so satisfying that it paralyzes efforts to gain satisfaction through the real. In the extreme it produces individuals who are entirely out of touch with the real and who become thoroughly deluded. In lesser degrees it produces: "shut in" personalities, whose joys come chiefly through inner contemplation, and to whom the world of events is of little significance; or "day dreamers," who drift on clouds and cannot come down to earth long enough to concentrate on any of their own problems; or "planners," who create situations within their own minds which they scarcely even try to materialize—buy books they never read, enroll in courses they never take, block out stories they never write, etc.; or drug addicts and alcoholics, whose artificial aids to phantasy constitute an additional danger.

The power of using the imagination is one of the most valuable man possesses. Without it life would lack color. In fact, its use is to be encouraged to relax the tension of combat with the real. It gives the "light touch" that enables a real worker to work hard and yet not to let problems obtain too much of a "strangle hold" upon him. Even frank day-dreaming is not always a vice, for it is from dreamers that creative work comes—if they harness their imaginations to reality, taking short flights away from it, and returning to it, bearing gifts. Imagination is the fountain of art and even of scientific

discovery, if it is kept in contact with the real world. It is a deadening substitute for life if it feeds entirely on itself.

Symbolization.

Throughout primitive and advanced civilization, human beings are and always have been addicted to symbols. They use them both consciously and unconsciously. There is always the danger, however, that the symbol will insidiously be permitted entirely to supplant the reality it symbolizes. For example, those whose emotions respond readily to the symbol of the flag or the cross may have little practical patriotism or religion. Similarly, those who are eager for marks—the symbols of educational achievement—may quite lose sight of what the marks represent.

To compromise with one's impulses by symbolizing their goals sometimes brings about a satisfactory adjustment; sometimes not. For example, when a childless woman showers her attention and her affection upon pets, her adjustment will not be considered a good one except by those who are symbolizing in the same way. On the other hand, the woman who interests herself in other people's children in lieu of her own is symbolizing in a way that is potentially more constructive, and probably will be actually so, both for her and for the children, if she is aware of what she is doing and why she is doing it, and prepares herself adequately for her career (e.g., teaching).

Much symbolization is partly conscious, but it may be entirely unconscious, as, for example, in the case of those whose mannerisms (stilted speech, pompous carriage, overbearing attitude, etc.) symbolize a great wish for a feeling of superiority.

Reaction-formation.

This term means going to the opposite extreme in expressing an unconscious wish. For example, a person who is inherently cruel may develop instead an exaggeration of gentleness; one who is inherently selfish may be known as the most generous of mortals; one who feels antagonism to another may go out of his way to show an excess of devotion; one who has an undue interest in sex may react against it in disgust.

Although this mechanism is largely an unconscious one, it often leads to very desirable social results (e.g., charity, chastity, good manners, etc.). Nevertheless, it is better to be aware of one's real tendencies if possible, and to place one's behavior on a conscious basis, for reaction-formation is likely to fail at times and the repressed wish to appear at the surface (e.g. outbursts of cruelty in the over-gentle).

Substitution.

When a much desired goal seems impossible (either hopeless or wrong), another may be set up in its place. The mechanism is called substitution if the second goal does not symbolize the first, and has nothing in common with it except that it is a goal whose pursuit and attainment would give satisfaction. In college it is often thought that the "grind" is using this mechanism, substituting intellectual achievement for the social success he cannot win. Probably the opposite is just as often the case; certainly many students turn their energies into efforts to shine socially when they feel that it would be futile to try to win academic distinction. In any case of substitution, rationalization is also likely to occur, to make the rejected goal seem inferior to the substituted one.

Substitution may be effective in helping a person to dispense with what is primarily desired and may give a satisfactory state of mind and a useful adaptation to life, provided the second goal is an important one, and is *pursued with interest and energy;* otherwise not. For example, women may substitute commonplace activities such as puttering over clothes for the ideal of romance and motherhood; but they are likely still to feel thwarted. Or they may substitute a significant sort of work (such as a business career) but not put enough interest and energy into it to gain full satisfaction from it or to prevent their ungratified wishes from rankling.

Sublimation.

Sublimation consists of substituting a second goal that does symbolize a primary one and that has much in common with it, the second goal being at the time and under the circumstances more fitting, more in accord with the whole personality, and on a higher social level. Friendships on a non-mating basis when mating is not to be considered afford an excellent illustration of sublimation.

It is certain that in a good many cases the choice of a profession is unconsciously made through the mechanism of sublimation. For example, that aspect of instinct which shows itself as "natural curiosity" may be sublimated so as to produce the research worker in science; or the crude impulse to be conspicuous among one's fellows may be sublimated so as to lay the foundation of great leadership.

Since the desirable mechanism of sublimation does not always take place of its own accord, it is important that the conscious mind be used to engineer this sort of adaptation. It may not involve establishing a new goal but giving a present goal greater significance by seeing it as a symbol. The teacher, for example, may learn to

look upon teaching not a drudgery to earn a living but as an opportunity for the most complete self-realization. It is possible to look upon many sorts of goals as somehow symbolical, and thereby to give them greater significance as goals and to derive from them greater satisfaction.

CONSCIOUS CONTROL

Suggestion.

It has always been more or less apparent that without the use of the conscious mind, the personality and the adaptation to living cannot be counted upon to be satisfactory. In their efforts toward self-improvement, human beings have utilized the conscious mind in numerous ways, one of which is known as *suggestion.*

All human beings are suggestible, or subject to a tendency to think or feel or act as something or somebody suggests. Everyone has a chance to observe this tendency in himself from time to time. For example, if one is told sufficiently emphatically and often that he wants a given thing he is likely shortly to begin to want it badly. Advertisers use human suggestibility to the great advantage of producers and the great cost of consumers.

One sort of suggestion—that which is made to one's self by one's self—is known as autosuggestion. It consists of thinking of what one wishes to do or be, and trying to implant in one's mind the conviction that such a state of affairs either is or will be. Fake psychologists have given much publicity to this method of self-improvement, and have made it popular because it sounds as though it would work and seems easy and harmless to try. They say "Think success and you will win it"; "Hold the thought of health and you will be well." There is, of course, an element of truth in this principle, but it is a dangerous one to use indiscriminately, because in many cases it amounts to turning away from the facts and diverting attention from the much more important practical steps to be taken toward one's goal. For example, those who think that the best way to overcome inferiority feelings is to "say to yourself that you are as good as anybody, and make yourself believe it," are in many cases trying to convince themselves of what is not so. Thereby they are missing chances to make themselves, not "as good as anybody," but so good as to deserve their own respect.

Autosuggestion is sufficiently powerful to make it necessary to use it with care, first, lest it make one too easily content in mind, without adequate reason; and, second, lest it make one unnecessarily discontented. One who asserts, "I am a failure" often enough,

can perhaps make himself believe that he is, even though he has only failed in a few tasks. Whenever that which is suggested is not wholly true, whether it be desirable and comforting or the reverse, it is as dangerous as any sort of evasion of reality or any rationalization. The same warnings also apply to suggestion made to others.

In all cases, when using suggestion it is better to stress values that really exist. Suggestion may justifiably be used to reinforce one's true beliefs about demonstrable realities and to cultivate a hopeful state of mind toward the future when judging it according to present reality (e.g., "I am 'college material'; I have passed examinations in the past; examinations are meant to be passed by those who study; I have studied; therefore, I shall pass this examination").

Will Power.

The student will perhaps think that will power should have been mentioned earlier as a means of correcting personality defects and gaining mental health. It has been omitted until now in order to show, first, the power of wishes. The old saying "If wishes were horses then beggars would ride" is intended to imply that wishing is futile. But wishes *are* horses, and beggars who wish hard enough *do* ride.

A wish carries with it the energy to get itself gratified, if it is a single strong one that does not conflict with any others and that promises immediate satisfaction. For example, one does not need any force of will to make one's self sit down to a good meal when hungry. But if several wishes are involved, and the important one will cause discomfort at the time and the others will give pleasure, it often requires a great effort to force compliance to the former.

A girl, for example, said that she had to use will power to take the anesthetic to have her tonsils removed. And a man said he did not have enough will power to stop drinking. What the girl did when she successfully used her will power was to review again and again the advantages of having the tonsils out, thus reinforcing her main wish to be comfortable and well. Thereby the wish had its way. What the man did was the reverse—he let his wish to stop drinking be blurred by other wishes. What was to be gained by abstinence (self respect, respect of others, better health, athletic prowess, or some other benefit) did not stand out clearly in contrast to the momentary pleasure of drinking.

Will power may be defined as the *intellectual faculty of keeping a wish in focus*. It should be used to full capacity after a suitable choice has been made among one's various wishes and the modes

for granting them. The method of using it consists of thinking hard about the real wish and the real benefits of having it gratified. If the wish is strong enough and clear enough, no great amount of will power will be necessary to sustain it, even when its gratification is necessarily in the remote future (e.g., in studying for a profession). Most people will find, however, that they must use their conscious minds not only in making their choices but often in keeping them in view.

Facing Reality.

In order to have a basis for the use of the conscious powers of control—in order to find out what to wish for and where to use the will—it is a fundamental necessity that one have the habit of facing facts. The real root of mental health, in the last analysis, consists of recognizing what is so, about one's self and other people, about the conditions in which one's life is set, about the ways in which changes can be brought about. And there must be not only intellectual grasp of these realities, but emotional acceptance of them.

Whenever one finds a person with good mental health it is certain that he accepts the world, including human nature, as it is and as it might logically be made to be. Although he may not put it into words, he knows that he must keep his inner demands parallel with those of reality. When he is beset by that which concerns him but is not acceptable to him, he does not turn away and say it does not exist, nor does he brood over it; instead, he turns toward it, and shoulders whatever responsibilities the eternal verities and the lesser verities of everyday life place upon him.

Chapter 47

THE SELF IMPULSE

Self-seeking.

Man is a self-seeking animal—that is, he has an innate drive toward self-preservation, which is aroused by that which threatens harm or promises satisfaction. On the physical plane these instinctive impulses are thoroughly familiar. They tell a man to eat when hungry; drink when thirsty; rest or sleep when tired; wear clothing and live in houses to protect himself against the cold; flee from certain dangers and attack others; etc. Also they bid a man to use his bodily powers somehow or other, and in general give him rather definite clues to the sort of action that will promote adaptation. To be sure, man is not so specifically gifted in some respects as the animals (e.g., birds that instinctively build nests, beavers that build dams, bees that build hives); but on the other hand, man's brain, whereby he can learn, more than balances any lack of specificity of impulses.

Man is, of course, not only a body, but an "I." Not only does his body need nourishment, demand protection, and require to be defended against all sorts of forces and agencies, living and otherwise, that threaten danger, but so also does his personality need psychic nourishment, protection, and defense; and not only does his physical self require a field for activity that gives satisfaction and pleasure, but so also does his mental self. He is driven to keep his psychic selfhood intact—native impulses cause him to try to sustain and to gratify his personality.

Ego, Super-Ego, and Id.

Freud uses these terms to indicate the three levels at which self-impulses arise. The *Id* is the self at its purely instinctive level; the *Ego*, the self at the level of every-day living, as modified by contact with the world and people; the *Super-ego*, a higher self, which is the product of respect early in life for parents and teachers and those in authority who set standards. It is a sort of unconscious conscience. The self-as-a-whole, the "I," includes these various selves and also the conscious self, with its motives and standards. In order

to avoid making this section unduly complicated, the term *ego* will be used to mean the self in all its aspects.

Dysphoria and Euphoria.

What the self *does not* want, indeed finds intolerable, are any of the feelings that may be classed under the heading of inferiority—feelings of insecurity, inadequacy, ignorance, weakness, guilt, shame, etc. What the self *does* want is fundamentally to rid itself of the feelings just described, and to gain the opposite. Man must have, first, the feeling of being safe and secure. This may be called the *safety motive*. Beyond that, man must feel pleased with himself for what he is and can do and does; he must feel important, able, free, wise, reasonable, virtuous, powerful. Not only that—he must feel that others look upon him in the same light. This may be called the "*super-man*" motive.

The tendency throughout life is to follow impulses that seem to promise euphoria. The difficulties of life arise largely through obtaining euphoria in the easiest way rather than the best way. If one is undiscriminating in satisfying any of his ego cravings, he is likely to have psychic indigestion, just as he would be likely to have gastric indigestion if, for example, he satisfied his nutritive cravings by a diet of pie. The physical urge to eat must be satisfied by food that agrees and nourishes, as well as gives gustatory pleasure; similarly, the psychic urges must be gratified in ways that *agree with* and *nourish* the personality.

Inferiority Feelings.

Since life revolves in one way or another around the attempt to change feelings of inferiority to those of superiority, it is important to consider what these feelings are, what they may mean, and what they cause people to do.

First, it should be recognized that everybody feels inferior, because everyone is born a weak and feeble infant and never does attain perfection. No one can always feel as noble and as able as he would like. No one can honestly feel entirely able to cope with all situations. Only the feeble-minded and the deluded abnormal will not sometimes feel inferior, for inferiority is an essential condition, *inherent in immaturity and imperfection.*

Second, feelings of inferiority may be greatly *exaggerated* as a result of experience. For example, a person may feel unduly inferior if he has been unduly humiliated in childhood; or has never managed to accomplish anything for which he could praise himself or others could praise him; or has a physical handicap which causes

him shame or embarrassment that extends over his whole mental attitude; or has made a single marked failure that gives a feeling-tone of inadequacy that colors all his emotions more or less thoroughly and permanently. It should be noted that in such cases one may not be *aware* of feeling inferior; the feeling itself may be so uncomfortable that the unconscious mechanism of repression or forgetting takes it out of consciousness before it is perceived; and the unconscious mechanisms for compensation may actually lead a person to feel superior. It is because the reaction to unrecognized feelings of inferiority may be either good or bad that it is necessary to consider the possibilities in such cases—as will be done in the following pages.

Third, feelings of inferiority of which one is conscious may be *rationalization*. They may have been unconsciously produced in order to defend one's self against effort and responsibility. If a person can persuade himself that he is inferior, less can be expected of him. If he recognized his abilities he could hardly fail to be impelled by the principle of "noblesse oblige"; by ignoring them or denying them he can have an easy life following instinctive leads toward pleasant paths and neither he nor others can blame him.

Fourth, there is a calm and reasoned belief in inferiority which is based upon facts. With this there will be a certain amount of feeling, to be sure, but it will not cause a person to be frantically eager to do anything at all to make himself feel better at once; instead it will lead him logically to embark upon real efforts to become really superior, even though the way be long and hard.

Superiority Feelings.

Because those who are born helpless become more or less able as time goes on, it is natural that everybody should feel superior to some other people in some respects. This feeling is as normal as one of inferiority. Both normally coexist. No one need ever lack any and every claim to superiority.

On the other hand, superiority feelings may, like inferiority feelings, be present to a degree unwarranted by the facts. Circumstances may accentuate them in those, for example, who have been pampered and coddled by indulgent parents. Often a single success early in life misleads a person into thinking that he is bound to duplicate it continuously. Sometimes superiority in one respect (e.g., in appearance) convinces a person he is superior in all respects. As has already been mentioned, a belief that one is superior is often a *rationalized* belief, based on the inner need to feel so.

A real belief in one's superiority is of course not justifiable unless it would be admitted by any competent and impartial judge.

Dealing with Ego Trends.

It is natural to wish to stand well with one's self, but it should not be so intolerable to admit lack of perfection. While holding to a high standard, one should recognize both faults and virtues. A recognition of one's own ability gives the reassurance that makes effort possible, and at the same time gives solace in view of the inevitable recognition of faults. No one is all good or all bad. No one should constantly feel either self-approval or self-condemnation —for neither will be in accord with the facts. As long as an individual is determined to feel thoroughly satisfied with himself, he is certain to satisfy himself too easily, and in ways that will harm his personality and in the end not make him happy but miserable.

One who feels aware of strong ego trends should ask himself daily: What am I trying to be or do or get in order to feel self-satisfaction? Are my present methods the best methods? Are they based on what I *know* about myself, or what I *feel?* Will they give enduring satisfaction? Shall I continue to like myself? Will others continue to like me? Shall I be a civilized human being?

In the following paragraphs an effort has been made to show how the various ego motives work, how they are gratified on a *crude* level by those in whom the ego badly needs support and comfort and reassurance, how they may be *sublimated*, and how they may be *consciously directed* into suitable channels of expression.

The Safety Motive.

Side by side in each person there is the wish to avoid feeling unsafe and the wish to strike out where danger but also ultimate glory and satisfaction may lie. Reality often drags one away from safety and protection, but many a person's life is governed by the inner need to stick to the tried and true in all relationships and all situations.

In the extreme, the safety motive may cause a person to cut himself off from all association with others and all contact with reality, lest his feelings be hurt. In less extreme degree, it may hold one back from the gratification of other ego wishes. It may, for example, keep a person from trying his powers, lest he be laughed at or criticized. The desire for safety from psychic hurts may be the motive that actuates those who will not take chairmanships, or act in plays, or go out for sports. It is often the motive in girls who will not go to dances lest they be wallflowers.

A very great need for safety often adversely influences one's life-work. It may make one unduly reluctant to undertake new work that might fail; or even to take up familiar work in new surroundings and with new people. It may even cause a person to temporize with his convictions for fear of losing a job in which he has become settled.

Normally the safety motive leads to a reasonable degree of conservatism, and is a balance against some of the motives that tend toward rashness. When sublimated, it is the foundation of loyalty to noble tradition, of faithful friendships, and of steady, well-seasoned policies in business, government, and personal, affairs.

Family and Home.

Adaptation to reality is very hard for some people when they first leave home. The appeal of safety and protection and family affection, and the desire for unqualified acceptance as persons worth consideration, draw them strongly back to the home ties. Valuable as family life is, in the support it gives its members, it must usually be dispensed with to some extent as one begins to grow up. Reality requires a certain amount of emancipation from parents and home. But in freeing one's self from bondage to the familiar, one is not, of course, doing violence to his affections, but merely developing them to an adult level, at which level they can be acted upon in ways that give greater satisfaction both to the individual and to his family.

Too great family fixation often interferes with happy marriage. A person may not marry at all, because he cannot find anyone who seems capable of giving the sort of devotion a parent gives; or he may find someone who he thinks can do so and later find that the mate had no idea of, or inclination toward, the assigned role.

The Adventure Motive.

The motive to seek adventure is the opposite of the safety motive. It causes a person normally not to be afraid of the new because it is new, but actually to seek contact with the world of people and events. This motive is often over-gratified by those who feel inferior. It produces people of the dare-devil type whose mottoes are "Try everything once" and "Live dangerously." Their rashness, however, is not true courage but is a mechanism to convince themselves that they are courageous. In a somewhat different way, exaggeration of the adventure motive will often lead a person to be unstable

at work, tiring of a job as soon as the "new wears off"—a good starter and a poor finisher, one who begins each task with enthusiasm and perhaps with ability, but drops it soon in boredom. Real hoboes belong to this class, and so also do the less commonly recognized business and professional hoboes, whose interests do not "stay put." The adventure motive may make fickle friends, who are "off with the old love and on with the new" in a perpetual succession, their capacity for friendship having breadth and not depth.

When sublimated, the adventure motive leads people to take up careers in which there is always something happening that is new, significant, and exciting—for example, pioneering in the early days of this country, or, in the present time, exploration in far lands. Certain professions give scope for the adventure motive—for example, the practice of medicine, especially of surgery. There is scope for the gratification of this impulse, however, in almost all lines of work. It is exhibited in those who have initiative and make new things happen to bring about improvements in whatever they are engaged.

The Fighting Motive.

It is just as natural to attack dangers as to flee from them. Most people like to "come to grips" with reality, of some sorts at least, and to conquer it. The victory is of course agreeable, but regardless of that, a fight is enjoyable for its own sake. This partly accounts for the popularity of sports, which give the participants a sense of power, in which onlookers share vicariously.

Those who particularly need reassurance regarding themselves may unconsciously try to convince themselves of their strength of personality by adopting a belligerent attitude toward others and seeking opportunities for combat. Whether they are particularly keen about having their own way or not, they enjoy having a "row."

When sublimated, the fighting motive leads people to be fearless of their personal safety in their attack upon wrongs (e.g., in a "war to end war"). It may make them risk any amount of personal discomfort in a cause in which they believe, even though they know it to be doomed to failure during their lifetime. Within their own selves it may make them willing to wage a winning war against habits they know they should overcome. If that were not so, no textbooks on hygiene would be necessary, nor indeed any education at all.

The Knowledge Motive.

It is instinctive to want one's knowledge to "grow from more to more," and to be pleased with one's self as a "knowing" person. Normally this motive leads to a desire to learn both by means of formal education and by experience. It gives intellectual curiosity beyond the needs of one's job.

One who is troubled within by feelings of inferiority may gratify the knowledge motive in certain unfortunate ways—for example, he may pry into other people's affairs and listen to gossip; or go too far in the effort to learn by personal experience; or become a dillettante, dabbling here and there and never really knowing anything; or rationalize about what he has picked up on the side-lines of culture, referring to his education in the "university of life" or the "school of hard knocks."

When sublimated, the impulse for knowledge gives the research worker in science and invention, archaeology, history, or any branch of theoretical or practical knowledge.

The Power Motive.

Everyone instinctively desires the feeling that he has power and that he is using it. Man delights in "subjugating Nature," the greatest force against which he can pit himself; but from the point of view of the power motive itself it makes no difference what power is used or for what objective purpose—the self-satisfaction is the same. It is man's comprehension of the significance of the object, and his unconscious bias, that makes the difference.

The satisfaction of using power comes from three main sources: (*a*) personal accomplishment; (*b*) self-direction; (*c*) directing or ruling others. Each of these points will be discussed in the following pages, after which several other aspects of the search for self-approval and the approval of others will be taken up.

Accomplishment.

Anything that a person can do makes him feel able; therefore doing must be considered an important source of euphoria and thus of mental health.

The aim to feel powerful in accomplishment is first satisfied in simple ways, all that one needs for reassurance is to be able to say "I did that," with stress on the *I*, and the *did*. In some, the status of accomplishment remains at that level. But usually there comes a time when one cannot be satisfied by merely doing anything at all, but must do something of significance—so that one can say "I did *that*," with the stress on the thing accomplished. For

example, in adult years a person will not take the same pride that he did as a child in strumming on the piano, but will require that his playing be musically at least acceptable.

The adult's aim is usually toward achievement in his career, which includes his vocation and his avocation. He seeks the thrill of using his powers to advance his personal and social aims. Whether it be running an organization, writing poems, bringing up children, copying a manuscript without error, or trying cases in court—when powers are fully used, it is always a source of euphoria.

The wish for accomplishment may be either understressed or overstressed, however; and it may be directed to false goals. There are many who are inadequately impelled by the power motive because it has been sidetracked by some other motive. For example, fear of failure may be so strong as to prevent trying for success (e.g., the student who will not take up tennis because others who are already proficient might look askance at a beginner). Frequently, also, the motive of accomplishment is lulled by a false sense of superiority already present (as in the case of those who have been spoiled); or by joys of the senses (as in the libertine, alcoholic, etc.); or by a life of phantasy (as in the day-dreamer).

One who has never done anything sufficiently well to feel a glow of real pride would naturally not appreciate the rewards of achievement, except perhaps in terms of money and the like. (That this is the case with many people is made evident by the fact that it is usually supposed that if a person works hard it is because his income would stop if he did not.) A succession of half-done chores all through childhood would certainly not cause an adult to know much about this important source of euphoria.

Not rarely people like themselves better in the martyr role than in the titan role, and actually prefer *not* to get pleasure in doing what falls to their lot, but to pity themselves for having to do it.

The desire to feel powerful in accomplishment may, however, be so great that it leads a person to busy himself about trivial things that can be done up promptly and give tangible evidence that something has been done. For example, a man may neglect his work in order to tinker with his car.

An exaggerated need for a feeling of power in accomplishment is based upon an exaggerated feeling of inferiority. One of the most unfortunate results of such a state of mind is that it may lead to an overweaning ambition.

Ambition.

Ambitions rise out of the ego's need for accomplishment or achievement. Normally ambition will be gauged according to capacity. Those who feel very inferior "hitch their wagons to stars"; those who feel very superior may hitch them to nothing. Happiness depends upon the choosing of an appropriate role, in which all the motives can have suitable expression—and then acting the part as well as possible.

The big achievement would, of course, be very acceptable to the inferior-feeling individual. Very often he allows the great, distant goal to consume all his mental energy, while the smaller, nearby, really achievable goals are neglected. This gives him a still further feeling of inferiority when he finds himself surrounded by tasks undone, and the great aim no nearer to fulfilment.

Mental hygiene requires attention to present tasks. That there may be some sure ground for self-approval, the ego motive should be used to activate some sort of real achievement through what is at hand. One of the first steps in overcoming inferiority feelings is to hold one's self to the performance of some one thing, even a little thing, to the best of one's ability, and then stopping only a very short time to admire one's self for it before attempting something else.

Sometimes big aims must be frankly given up, for the time being at least. Giving up is not always a negative thing, but often a positive achievement of great psychological value. It may take more courage and clearness of thought than one possesses, to admit any disability. Yet at times the whole future of the mental health may demand it. In such circumstances, giving up is not cowardice and retreat, but bravery and a step forward.

"Pride of Possession."

Man quite naturally projects his ego upon his possessions or identifies himself with them, or uses them to symbolize his personal attributes. The more he has, the more of a man he seems to himself; the finer the quality of what he has, the finer his personality seems to him.

Because it is true that possessions do pertain to the self and reflect its traits and attributes, other people are likely to judge a person at least partly by what he owns. This popular method of estimating worth merely intensifies man's natural tendency to gain reassurance, even glory, by what he can accumulate as his.

It is, of course, true that to possess much a person must usually be worth much as a person, and that to possess things that are

fine, or rare, or beautiful, he must usually be a person of discrimination; but one may be of extraordinary worth to the world and yet have not "where to lay his head."

Much of man's progress has come about through the efforts made for possession, and there is much to be said in favor of utilizing this motive to activate personal achievement, and even in favor of permitting the ego this sort of aggrandisement and the euphoria that comes therefrom; but to let the ego be proud only, or chiefly, through what is essentially outside it, is to fail to gratify it in other more vital ways.

Power over Self.

Although the major teaching in regard to the ego is that of acquiring the power of self-direction, there are times when even this power is used too readily, in trivial, useless or even harmful ways. The idea "I am master of my fate, I am the captain of my soul," is one that inevitably exerts a strong appeal to every strong personality, and they may be swayed by it when it would be better for them not to demand so much inner satisfaction. In fact, gratification of this power motive often amounts to a serious form of self-indulgence. For example, a parent may glory in his self-denial for his children, when it would be better for the children if he could forego the pleasure it gives him to spoil them. Similarly, often it is stupidity along with false pride in one's power of endurance when a person bears pain in patience; if he were less proud of himself for his fortitude, he would be more likely to attend to his health. Because faults such as these seem like virtues, they are dangers of the strong, not of the weak.

The weak personality is more likely to use his desire for a feeling of power over himself by becoming negativistic or contrary. Many people cannot accept another's advice—to say nothing of following orders—because it accentuates their feeling that they are weak. It seems like a loss of personal power when they allow others to influence them. If they were sure of themselves, they would not be so easily cast down from their pinnacle of self-pride.

Those who show the rebel spirit, who defy regulations, seek freedom (with a capital *F*), often do so because they feel bound and helpless within, and strive vigorously to shatter the bonds of their weakness. It reassures them every time they can make it plain in word or deed that they have liberty, can manage themselves, do not need guidance by law or statute, or by any dicta of authority. Not only do they break laws and customs, but they often feel that these

are unnecessary trammels upon civilized people, and would establish if they could a state of anarchy—all because they feel weak and want to feel strong.

The person who really feels that he has himself in hand has plenty of chances to prove it to himself in his everyday life (when, for example, he makes himself get up on time, keeps his appointments promptly, takes the exercise he needs, etc.). He will delight in being a real master over himself when there are hardships he must bear without complaint, pain he must bear without flinching, temptation he must resist, pleasures he must deny himself, efforts he must make; and he will not have to make futile gestures of mastery. Every person who amounts to anything in life will thus have sublimated the power-over-self motive. Usually he will have settled the conflict between personal liberty and social welfare also, and will find that making himself conform to his and his fellows' code is a better source of euphoria than showing his power not to conform.

Feelings of Guilt.

One of the most painful feelings of inferiority is that of self-blame on moral or ethical grounds. If the feeling corresponds with the facts, it obviously is likely to have a constructive effect, causing one to correct faults or atone for them. But sometimes the feeling of guilt is fictitious, aroused perhaps in the first place by self-blame for a minor error that was conceived as of a heinous offense (e.g., the phantasy type of lies that children tell, or the sex play of childhood). It is natural to blame one's self at times, for no one is perfect; but it is unnatural to blame one's self constantly. If such a mood prevails, it may usually be concluded that it is not a valid one. It would be well to discuss it with one's religious adviser.

Various unconscious mechanisms are used to compensate for a feeling of self-blame. One of the most unfortunate is the *tu quoque* (you also) mechanism, whereby the individual relieves his own feelings by convincing himself that others are as bad as he.

At a high level compensation may take place by a life of self-denying service to others. It may even lead to willingness to undergo martyrdom in atonement.

Power over Other People.

Those who feel particularly inferior may find it easier to get satisfaction from using their power over others than over themselves. They are likely to take advantage of any social relationships to do as much managing as possible. For example, as parents or teachers

they may overguide children; as husbands or wives they may nag; as children they may be tyrants over parents; as executives they may be martinets. What they like is authority for its own sake—the power to make others do their will.

Often it is those who have themselves been browbeaten who overcompensate for their still present smarts by wishing to make everybody bow down to them, and they may even unconsciously wish to make others smart as they have. Since it usually is children and others who are comparatively helpless (especially relatives who must put up with it) upon whom they can most readily impose, and since they could not fail to blame themselves if they admitted their self-indulgence in cruelty, they are driven to rationalize that it is "for the good of" their victims.

This sort of person fits into group life poorly. He likes to control situations—for example, to interfere when things are going smoothly, to impose conditions that a whole group has to meet, "tie other people's hands" so that they must necessarily consider him. He is the sort of troublemaker who makes trouble just to show that he has power to turn things topsy turvy. A good many scandalmongers belong to this group—and those who circulate rumors.

A strong, unconscious wish for power over others usually leads a person to follow a career that gives it scope. On a crude level he seeks any sort of situation in which he has control over others, and then uses his opportunities to domineer to his heart's content. Every time he makes anybody do his bidding his own sense of importance rises, especially if he can make them positively cringe. The ward boss is often of this type. Petty tyrants in education, business, and professional life—all walks of life—are very numerous.

When sublimated, this desire to control and influence others is what makes leaders—those whom others gladly follow. To be a great executive, or diplomat, or editor, or teacher, etc., a person must want to lead, but he must want to lead wisely and must be willing to prepare himself to do so. It is worth comment, however, that even a sublimated motive for leadership may do harm when it points away from achievable goals toward remotely impossible ones.

Popularity.

Having discussed various ways whereby a person may try to convince himself of his own greatness and worth, to gain *self-approval,* it remains to discuss one of the most important ways of all—that is, by securing the *approval of others.* Most people cannot really like themselves unless other people like them. This is a good thing,

for it keeps up the high standard of civilization. But people differ in the kind of liking they crave, and also in the source from which it must come. Some crave warm, personal affection from those near and dear to them; some, remote admiration and approval of the world at large, or the small section of it that knows them; some, mere popularity, with anybody and everybody.

A desire to be liked in a promiscuous fashion always springs from inferiority feelings, and often leads to shortcuts to popular favor that affect the personality very adversely. It may, for example, narrow one's sphere of friends to the few that are easy to impress. Also, it may limit the scope of one's activity to that which one can do well and for which one is absolutely certain not to be laughed at or scorned. And it may restrict one's zone of activity to a region where one is already known and liked—to prefer to be a "big toad in a little puddle."

Personal relationships, even with friends, are apt not to be easy and comfortable for the person who cannot believe in himself or like himself unless others do. He is inclined to be sensitive and "touchy." He readily feels that he has been insulted or ridiculed, because at the first sign of criticism his own self-respect vanishes. When a person feels inferior he is often so eager for praise that his friends finally become weary of thinking up new ways of complimenting him. To stand well with others he often flatters and fawns upon them in a fashion that repels all others except those who also have inferiority feelings that need salving. Perhaps most unfortunate of all, he may conform to the standards of others when he does not approve of them, so that he will not lose friends—for example, much alcoholism originates as passive compliance for "friendship's sake." Social errors of any kind he usually dreads because he feels they would put him beyond the pale.

Those who are most insistent upon the use of their titles, and upon receiving all honors due them, and all rights of precedence, often betray how doubtful they are of their real worth. Distinction is a legitimate goal, but no unearned crown of laurels ever rested comfortably.

When sublimated, the desire for the good opinion of others is the root of the best traits of personality and the best adaptation to life. It involves correlation with the social impulses, which are discussed in Chapter 49. Briefly, it may be stated here, that being admired and being admirable both have their root in the same need, and that if the latter is the aim the wish for the former will be gratified.

Exhibitionism.

The need for "showing off" comes upon a good many people from time to time, and is present constantly in some. They show how inferior they feel by their unconscious attempts to cause others to "stop, look and listen"—by their conspicuous clothing, which fairly shouts to be seen, or their excess of make-up, or their noisiness, or some sort of behavior that cannot fail to attract attention. It may not be simply poor planning, for example, that makes certain people always late to group gatherings, but unconsciously good planning to make their arrival noticeable. Many college capers originate as attempts to rise out of obscurity by any means that accomplishes that result. Newspapers are filled with accounts of the doings of those who are more thrilled at seeing their name in the paper than by the thing they did to get it there. Society columns are apparently largely to gratify this desire (and also to give humble readers a chance to feel vicarious satisfaction).

A well-balanced person may like to "put himself across," but will not crave to attract any but favorable attention. The lime light *per se* will not please him unless it catches him at his best. Therefore, he builds up the power within himself of appearing to advantage and then lets himself enjoy the regard of the public eye. When suitably sublimated, the desire to be prominent provides those who enjoy filling positions that are particularly difficult for many others (e.g., lecturing, acting), which is a fortunate thing, since the world would be the loser if everyone were of a retiring disposition.

Manners and Inferiority.

The general impression is that if a person acts humble he feels inferior, and that if he acts "high hat" he feels superior. The reverse is more often the case. Those who are not sure of themselves often try to reassure themselves, and others, by acting as if they had all the confidence in the world. The truly superior do not have an inner need to advertise themselves by their manner, and are calmly at ease, unassertive, even modest.

When a person appears conceited he is often trying to convince himself of his own worth. One with an unusually haughty, supercilious manner may be unconsciously using this manner to overcome the opposite tendency, toward shyness and diffidence. In fact, the inferior-feeling individual may show both manners alternately—approachable one day and distant the next, perhaps "cutting" people or "putting them in their place." Outbursts of very

bad manners (e.g., rudeness, brutal frankness, loud talk, etc.) are common in those whose self-esteem is uncertain.

An egotistical bearing certainly always indicates an interest in giving an impression of importance, and sometimes really is due to the cause to which it is commonly attributed—a feeling of superiority. When due to this cause, the cure in young people may be expected to come about through a series of hard knocks, but if inferiority is the cause, understanding, kindness and appreciation are more often of assistance. A knowledge of the two possible sources of bad manners often helps one to get along better with those who are "difficult" and whom one would perhaps be inclined to leave alone in their glory.

"Alibis."

In order to be pleased with themselves many people use the mechanism of projection in unfortunate ways. Whenever they are at fault or would feel so if they admitted it, they blame their circumstances or their associates. It is entirely reassuring to one's self-esteem to be able to think and to say "I never had a chance." Those who must excuse themselves often lean too heavily upon lack of opportunity, lack of "pull," lack of education, poverty or poor social status of the family, too many burdens unfairly placed upon them, false friends—anything will satisfy such an individual better than admitting that his remarkable self was at fault. In common parlance he establishes an "alibi" for himself. The phrase "If it had not been for—" is one to guard against. So also are the phrases "I didn't think," "I didn't mean to," "I was out of sorts," "I wasn't feeling well," when used to account for derelictions in duty, disposition or deportment.

"Great I, Little You."

If a person can make out that others are inferior, he will shine by contrast. A common tendency is to belittle others and to that degree to raise one's own status. This is evidenced in the politician slinging mud, the merchant tearing to shreds his competitor's reputation, the unattractive girl casting slurs upon other girls of superior charms, even questioning their morality. Some pretty women never see another pretty woman. In schools, children often belittle the successes of a mate by calling him "teacher's pet," thus taking away any credit he might have for personal accomplishment.

Nothing is more successful in belittling others than making fun of them. In fact a sense of humor is cultivated sometimes solely in order to serve this purpose.

Camouflage.

Various sorts of camouflage are used by various people to help them gain popularity among their associates. For example, many people pretend to know a great deal more than they do. Either they simply pretend or they dabble about in culture and apply a veneer of it. There are expensive short courses to cater to the needs of such. To camouflage social status, clothing may be worn that corresponds to a role one cannot or does not, but would like to, fill (e.g., to show wealth, sophistication, a leisure life, an interest in sports and all that that implies, or even to show girlish innocence). Equally useful is affectation of mannerisms or a style of speech to show qualities not possessed (e.g., delicate nurture, or worldly experience, or superiority of intellect). In conversation many a person hides his real beliefs not so much to avoid an argument or because he is ashamed of them as because he thinks he will not be approved if it is known that he holds them.

To "put up a front" of any sort would of course not be necessary if one were what one desires to be, but there is a certain social value in acting like a cultivated person whether one is or not. Cultural camouflage is not entirely to be condemned unless it amounts to deceiving one's self and thereby crippling real effort for the real thing, or deceiving others to their disadvantage.

Deceit.

Deceit is either lack of directness or frankness, or actual misrepresentation, or lying. Even in those who deliberately and consciously use deceit for unworthy purposes, the underlying motive may be the unconscious wish to overcome feelings of inferiority.

Perhaps the commonest cause of lying is the wish to appear well in the eyes of others—that is, for the purpose of self-aggrandizement. Lying also results from fear. It is the resort of the craven coward who dares not face the consequences of stating things as they are. Those whose safety motives are very strong lie thus for self-protection. Another form of lying is for the purpose of injuring others; but it does not necessarily involve malice. It may be chiefly in order to make the contrast greater between the individual about whom the falsehood is told and the teller of it—the latter hoping to rise in popular esteem as the other falls. Finally, lying may be due to inability to distinguish between what is true and what is false. Such blindness is quite general in children, before they have learned to check their normally vivid imagination with reality. If it persists into adult years, it is because the individual has not abandoned the

habit of phantasy, or because, by rationalization, he can make himself really believe what is not so.

When the tendency to lie is very pronounced, it is often associated with a tendency also to steal. Such a condition is definitely abnormal.

Friendship.

It is ordinarily a sign of poor mental health either not to want friends, or to want them and not be able to make them, or to make them and not be able to keep them. For mental health, the aim should be to have many friends, lasting ones, of many different sorts, but without too great dependence on either side.

Friends will be relatively unimportant to those who are so preoccupied with dreams that real people seem less real than imaginary ones; and relatively too important to those who seek support of their ego largely through others. In either case, feelings of inferiority may determine the trend. On the other hand, aloofness may result from a superiority complex which makes everybody else seem inferior to one's self. Also, those who idealize life as a whole are bound to find that most people do not measure up to their lofty standards.

Friendships are most commonly made upon the basis of propinquity, and undoubtedly this is one of the best bases for them. The ability to be friends with, and to get on with a roommate with whom one happens to be thrown by chance is often a good test of mental health. It should be possible to find much in common with anyone with whom one has to deal. Naturally, one's best friends will be those with whom one has the most in common. There is often, however, much self-interest in making friends (e.g., for the "pull" they afford, for the homage they pay, for the domineering they put up with, or even for the hero-worship they allow). These and other self-seeking trends are likely to break up friendships. When a person readily makes friends, but cannot hold them, it may be because he demands too much from them. In a real friendship there will be reciprocal give and take—each does much for the other, but conversely each must usually bear something from the other. No friendship is ideal in all details, but any real friendship will be valued and guarded as one of the boons of living.

Wide and Deep Interests.

The mentally well usually have at least one absorbing interest into which they put a great deal of energy and from which they obtain much euphoria. Ideally, it is fitting that the deepest interest

should be in one's work, but in many cases it must center in an avocation or a hobby.

In addition to their chief interest, the mentally well usually are interested in a wide variety of things. Their thoughts and their activities reach far beyond the scope of their daily work. With Terence they can say, "Whatever concerns humanity is of interest to me."

It should be noted that college curricula are organized according to this principle of mental health, allowing scope for depth of interest in the major subject and breadth in numerous other subjects.

Introverts and Extroverts.

The introvert is one who turns within himself and relates his environment to himself. In every situation the effect of it upon him is the important thing. He is likely to find his joys of all kinds within himself. Those who are strongly introverted are often seclusive, of the "shut-in" type. They are likely to develop *ideas of reference*, to think that what people do or say has reference to them. For example, if a conversation stops when they enter the room, they are likely to conclude that people had been talking about them. In the extreme they may become quite deluded about such matters.

The extrovert turns outward. He projects himself upon his environment. Unlike the introvert, he makes friends readily, does not know what it means to be snubbed or slighted, usually expresses himself fluently and is glad to do so upon all occasions, likes to occupy the center of the stage, and is comparatively free and unhampered by people and events.

The trend the personality takes in either of these directions is usually determined early in life—indeed it often seems inborn, it appears so early. Thereafter it influences the unconscious choice of mechanisms (e.g., the introvert type tends to phantasy, and the extrovert to exhibitionism) and the conscious, or unconscious, choice of a role in life (e.g., the introvert may seek accomplishment in his own study or workroom, and the extrovert may seek to live in the public eye).

In general it is well to guard against extremes in either of these directions. Because the extrovert is in closer contact with reality, his tendency usually leads to better adaptation in the here and now. It is the extroverts who take the "practical" steps toward advancing civilization. Because the introvert is more inclined toward theoretical matters, it is he who establishes our philosophies, or religions,

and our standards for the intangible in general, and who does much of our scientific research and invention.

Introversion, however, more often leads to mental ill-health than extroversion, unless the introvert is very careful to keep himself in the world and of it. Extroversion, on the other hand, may cause adaptation on too trivial and superficial a level. Whichever tendency a person has, he should strive to balance it with the other.

Chapter 48

THE SEX IMPULSE

Instinctive Elements.

One of the most striking features of life in all its forms is that it seeks not only its own continuation but also that of the species to which it belongs. Survival of the species, like that of the individual, is made possible by the inborn tendency to be stimulated in given ways toward given acts. The tendency is based upon certain sensory urges and their emotional counterpart—together called the *race-preservative* impulse because it serves to ensure the propagation of the race; or the *reproductive* impulse, since it leads to reproduction of individuals, whereby the race is preserved; or the *mating* impulse, since mating is the means by which reproduction and race preservation are accomplished; or the *sex* impulse, since it is because of sex interests that mating is desired.

Like all native impulses, the sex impulse establishes a state of dysphoria in order that action shall take place to produce euphoria. The dysphoria it creates may be sensory or psychic or both, and may be slight or pronounced, according to the individual in question and to the stimuli to which he is subjected. The euphoria it seeks may also be sensory or psychic. The impulse may be repressed or diverted from its natural goal; or its natural goal may be sublimated by means of voluntary control.

On the sensory side, sex impulses arise early in life, but are not urgent until puberty or after, when the reproductive glands affect the whole organism in such a way as to accentuate them. On the emotional side, sex feelings do not develop as such until after puberty, at which time there develops normally both a physical and a psychic attraction to the opposite sex, which leads sooner or later to the phenomenon of "falling in love."

Physical Attraction.

On its simplest and most fundamental plane, the attraction that leads men and women to mating is physical—that is, it arises and culminates through the senses. Usually the first sense to be aroused is the visual. Through the eye two people first become aware of

each other, and impressions thus gained may at once determine whether further attraction is possible.

The determining factor may be not merely the appearance as such, but what it is felt to indicate biologically. In a matter involving race-preservation it is natural that there should be more or less universal standards of beauty, based upon what is good for the race. These unconsciously influence men and women to choose mates whose appearance seems to indicate that they are fit for parenthood. An appearance of health and vitality—of normality and soundness of body and mind—is virtually essential to sex attraction. Form and feature, color, carriage, expression—all must have this significance. An associated factor of great importance is cleanliness, which has the same esthetic and biological significance. Only in the most sensual is sex itself enough to arouse attraction, and appearance not important.

However, the sex impulse is still more selective; the determining factor in attraction is usually a highly individualized preference. Regarding appearance, beyond the factors of biological significance there are factors that to a given individual are of great personal significance. Such individual preferences—as, for example, for blondes or brunettes—defy explanation; and when it is a question of preference for a given individual, they may be quite unaccountable according to any esthetic standards. Furthermore, individual preferences extend to other senses than vision; the olfactory sense and the ear are, for many, as exacting as the eye.

Important as physical attraction is as a basis for mating, civilized human beings are inclined to feel that in itself it is not enough; it must be part of a more diffuse attraction of personality and intellect, or it is not love.

Romanticism.

Sometimes attraction remains at the sensual level but becomes surrounded by an aura of romance, the product of the phantasy mechanism. The personality of the beloved shines with the light of one's own imaginings. Unconsciously one endows the other with qualities he or she never possessed. This is done to justify one's taste; one must feel that this is not an ordinary person whom one has captivated.

There may be virtually nothing real upon which such an attraction is based, except the appeal of the senses, and even that may be minimized in order to make the attraction seem on a high plane of idealism. This is the sort of "love" commonly known as infatuation.

It is usually transitory; the more brightly it glows for a time, the shorter its duration, as a rule—which is fortunate, for real love is not founded upon fancy but upon fact.

Many individuals upon first experiencing a sex attraction of great intensity are inclined to believe that it is the only emotion of that kind that they will ever feel, and to believe that if that romance does not culminate no other ever will come to them. They are consequently very much in earnest about it, worried about the outcome, and sometimes marry on the basis of such an assumption, perhaps against their better judgment. It is quite a mistake, usually, to believe that this sort of love can be aroused only by one individual, or that it comes only once in a lifetime or that it necessarily means love. It appears to be rather the exception to fall genuinely in love with the first individual who arouses one's emotions.

Love.

At a higher level of attraction is the emotion that deserves the name of love. It is not "blind" as tradition has it, but clear-eyed. To be sure it idealizes, but does not exclude a concept of the real person. Since it does not depend entirely upon illusion, it is more likely to be lasting. Also, real love is sublimated beyond the sensory and selfish level, and is not only a sensual and romantic relationship, but a companionship as well. Finally, real love is altruistic. It seeks at all costs the welfare of the one who is loved. In those who are capable of it, such love throws a glory around life that is not dimmed even by the renunciation of all that is personal.

Marriage.

Marriage should be undertaken only when love is present, and when, from all points of view, the marriage contract seems to be a sound and expedient one, and one which can be fulfilled by each of the partners. Under such circumstances, it should be the most perfect of human relationships. It offers each partner a warmth of devotion and appreciation and sympathy, a closer bond of understanding, than comes from any other association. It is worth whatever it demands of each in the way of compromise. Naturally, however, the perfection of marriage does not spring into full bloom at once, or remain so, without nurture.

The emotion that draws two people together in marriage will give them the intention to adapt to each other and to whatever their life together involves, but intention is not enough. They must cultivate the ability to carry it out. Many significant details of getting along with others must be grasped. For example, a husband

and wife must understand even better than mere friends and acquaintances the little ways in which another's ego instinct may be gratified in everyday life; and particularly they must understand what the major satisfactions of the ego instinct, in the career, mean to each other. The support that married partners can give each other in self-realization is one of the flowers of the altruistic aspects of love. But, as has been said, to act upon emotions one feels for another, the emotion must be supplemented by knowledge and thought, planning and practice. A truly successful marriage almost always represents good mental health on the part of both husband and wife.

When marriages fail it is most often because they were founded upon phantasy, and when the phantasy collapsed one or the other partner was unwilling to let it go and adapt to the real mate. In such circumstances, naturally, incompatibility of tastes and interests appear. Generally speaking, incompatibility means poor personality adjustment between two people, either or both usually being poorly adapted to life as a whole as well as to the mate. It would appear that a psychiatrist should be sought instead of the divorce court when marital harmony is lacking—and this applies to lack of harmony on all planes, even in regard to sexual compatibility. The latter should be present when love itself is present; and it should persist.

Early marriage has been advocated as a remedy for the conflicts that arise around sex. It should be noted that this would remedy the situation only in some cases, for not all individuals are in a financial position to marry early; and even for those who can marry early the problem of sex is not necessarily settled permanently. The individual who cannot solve his sex problems before marriage should not count on having them all solved by marriage.

Celibacy.

Although it is normal and natural to marry and to have children, it is not unnatural to remain unmarried. In fact, the majority of persons do not marry for some years after they are biologically ready for it and after sex impulses have begun to be urgent. The question arises whether the denial of sex impulses before marriage is harmful.

This question has repeatedly been answered in the negative by scientific authorities such as the American Medical Association and the American Public Health Association. The latter organization

states that "continence in both sexes and at all ages is compatible with health and normal development." Pronouncements such as this have been made to overcome the popular impression that for men sex expression is a requisite of manly vigor. Not only is continence safe, but it is also possible, with men as with women, whenever it is not suitable that marriage should take place.

A second question often arises in the case of the unmarried—even though continence does no harm, it represents the denial of a natural impulse, and why should it be denied?

For some persons that question does not arise. Denial of sex outside marriage is easy for them because they feel no sexual attraction at all except as part of the highest sort of love. They need not resist casual sensual affairs because such affairs would seem to them tawdry and dull—quite distasteful. Fastidiousness regarding sex and love is not only a trait of women; many men are equally repelled by the crudely physical or the spuriously romantic. It is a matter of fine discrimination in values—a preference for only the best.

However, for many individuals it is by no means easy to deny sex its natural expression. When they do so it is usually for one of the reasons to be mentioned in the following four sections.

Social Reasons for Renunciation of Sex.

Many individuals deny themselves sex freedom because they respect the institution of marriage—the only socially sanctioned form of mating. They realize that it sprang originally from a genuine social need. It cannot be imagined that mankind would ever have set limitations upon natural impulses unless it had been the feeling of the whole group that such limitations were necessary.

In looking back over history, and considering the contribution of marriage to human progress, it appears that it has had particular value in respect to the rearing of children. The rights of the child are the basis of most of our highest standards—and it seems that there could hardly be a better foundation for the personal development of all concerned, and for society. The family as a unit meets the requirements of the individuals that compose it and of the community that families compose, even though it does not always do so perfectly.

The advantages of monogamy have been questioned, especially by those who feel restricted by its bonds, but society has not seriously questioned its advantages as a means of promoting family welfare, social stability, and also individual happiness.

Those who deny themselves sex expression outside marriage respect the theory of marriage and its value to the human race; and they desire to help rather than hinder the upward trend of mankind. They realize that the whole social structure is based upon the effort through the ages to rise above the level of action on unmodified instinct; and that the whole social structure is affected by each lapse from higher standards. Even though they can foresee no possible harm to themselves or any other individual, they are willing to deny themselves for a principle.

At a somewhat lower level, there are those who appreciate the practical aspects of society's attitude toward sexual non-conformists, and the punishment that in most social groups is visited upon them. Public disapproval, expressed by partial or complete ostracism, depends of course upon what is known about a person's private life; but it is notable that what is not actually known regarding a promiscuous person is usually suspected, and that the results are the same. In almost any group, a woman who violates the code will find her social standing and her career handicapped; and men are not exempt among social groups with high standards. While monogamy prevails, both men and women who fail to observe its obligations do so at their social peril.

Renunciation for the Sake of Marriage.

There are many who respect the institution of marriage not only theoretically, but practically, expect to marry happily themselves, and do not want to put any stumbling blocks in their way to prevent or to mar their marriage.

They realize that affairs before marriage may lead to a marriage that would not otherwise have taken place—and one that may be a poor substitute for the ideal marriage that had been contemplated with a quite different mate. Also, they realize that such affairs may prevent a marriage that might otherwise have taken place; even though marriage is contemplated, too great intimacy before marriage may cause the attraction to wane, especially if it is on the conscience of either.

Finally, they realize that pre-marital intimacy may effectually shut off the possibilities of a marriage with any other person—either because the affair is so engrossing as to prevent making other friends, or because other possible partners, if they suspect the nature of the affair, may be repelled. Whether from possessiveness or jealously or wholly from idealism, many people wish their mate-for-life to be, and to have been, only theirs. Certainly those who have

casually overstepped the bounds, both men and women, often regret it, when it later threatens the perfection of a life-long relationship.

Physical Reasons for Renunciation of Sex.

One of society's reasons for not countenancing extra-marital relationships is that they are likely to bring fatherless children into the world and to spread venereal disease. To the degree that strict observance of the standards of monogamous marriage prevail in a community, these two dangers are both decreased.

Those who respect the physical danger of infection or of pregnancy are well advised. There are no preventive methods that can be implicitly relied upon, and those that exist are, for one reason or another, less reliable under circumstances of casual relationships than within marriage. Although pregnancy outside marriage is more serious for women, it may cause serious complications for the man as well (e.g., an undesired and inappropriate marriage).

Renunciation for Peace of Mind.

Since social standards are as they are, the individual will be both consciously and unconsciously influenced to conform to them; and the social impulse speaks as loudly as the sex impulse. Also, the super-ego, his best self—the product of the individual's upbringing at the hands of parents and other early guides—sets for him certain standards of an ethical and esthetic nature.

When a conflict arises regarding the gratification of sex outside marriage, many a person realizes quite well that he could not stifle the impulses that come to him through social standards and from his super-ego. He knows that having developed a high standard one is virtually compelled to live up to it or to suffer misery. What often arises is loss of self-respect for lack of self control, or for disappointing or harming others, or for yielding to the purely sensual in violation of higher standards of love. One may react in disgust with one's self against a relationship that lacks the romance and idealism and altruism of love.

For one reason or another it appears that inner turmoil is often the chief result of love affairs outside marriage, and many people, realizing that fact, choose deliberately to deny sex until its expression has the approval of their whole nature.

Autoerotism.

At the time in adolescence when the sex impulse becomes strong, or indeed at any time in life, a habit may recur which is first mani-

fested in infancy—that of masturbation. It is a purely sensory gratification, and in the infant has not the same sexual significance as in the adult. It appears to occur in the infant as a part of its general interest and curiosity about its own newly discovered body. It finds that it has fingers and toes and enjoys playing with them; also it takes a similar interest in the genital organs. Unless attention is unduly focussed upon the habit, it is usually abandoned as the child becomes interested in its surroundings and ceases to be narrowly interested in itself. Later, the habit may be resumed as a means of sensory gratification.

At no time in life is masturbation as physically harmful as is popularly supposed. Nor is it the cause of mental disease, nor the result of it. But it may be somewhat harmful to the development of the personality. The term *autoerotism* means self-love. Often those who are the most seriously addicted to masturbation exhibit self-love in a number of ways; they are likely to be self-centered and self-indulgent, and to find the greater part of their satisfactions, both sexual and otherwise, in themselves. The mythical Narcissus, who admired his own reflection in a fountain is the prototype of the autoerotic personality.

Obviously, the personality at the infantile level of development will be hampered in a world of adults, and should take the next step, just as the normal baby does—that of widening his interest. Although masturbation may occur in those of other types, it seldom becomes tenacious except in those of the type mentioned. In any case, it represents a departure from the adult level of emotional interest, and should be abandoned in order to open the path to full development. The methods of breaking the habit are the same as those to be mentioned for the general control of the sex impulse.

Homosexuality.

At the time in babyhood when the interests normally tend to widen, they are at first centered in others nearby. Then comes a period when the interests are chiefly in those of the same age, whether male or female. Shortly, however, boys begin to flock with boys and girls with girls. This childhood level of interest in the same sex is called the homosexual level. It implies nothing of sexuality in the adult sense, but merely a center of interest emotionally. Often it persists until puberty or after, the members of each sex usually much preferring as companions those of their own sex.

When the time arrives when a person tends to fall in love, if he is still at the homosexual level of interest, he may become intensely

attached emotionally to someone of the same sex. This is particularly likely in those of strong affections. Such attachments among girls are called "crushes," but they occur often among boys. They are characterized by a marked dependence upon the object of the affection, and a degree of jealousy that makes these affairs on the whole apparently the cause of more misery than happiness.

There is ordinarily little or no sexuality in "crushes" yet they seem to have some importance as a mode of sex expression. Homosexuality, like autoerotism, is of significance chiefly because it may be relied upon to solve sex problems, and because it is not an adequate solution. For those who have not yet reached the adult heterosexual (man and woman) level of interest, intensely emotional attachments to those of the same sex may check normal development. For those who have reached that level, a reversion to a previous level of interest is an evasion rather than a solving of problems of sex; progress involves moving forward and the meeting of adult problems on an adult level.

It need hardly be mentioned that the sort of over-emotional attachment under discussion is to be distinguished from friendships between those of the same sex. Friendship has nothing in common with the violent "crush" characteristic of the homosexual level. One of the finest manifestations of adult development is the ability to give and to receive close and loyal friendship; and that sort of friendship is indeed of major importance in the solution of many of life's conflicts, including those of sex.

Mature Attitude toward Sex.

Some individuals at adolescence are not attracted but repelled by those of the opposite sex. Perhaps the most pronounced "man-haters" and "woman-haters" occur among boys and girls in early adolescence. Often this is due to an unconscious effort to combat the newly developed emotional interests in the opposite sex; these interests, scarcely appreciated as such, are felt to be inimical to peace of mind, and are repressed for self-protection against further disturbance. It often happens, however, that the one who most completely rejects all interest in the opposite sex may swing as far in the other direction when he or she finally ceases to create an artificial lack of interest, and may fall violently in love with the first member of the opposite sex to break down the defence mechanism.

Failure to develop a mature attitude toward the opposite sex sometimes apparently occurs because the individual has been

environmentally situated so that opportunities have been unfavorable for the normal extension of interest; sometimes because of early unfortunate experiences showing the opposite sex in an unfavorable light (e.g., discord between parents); but most often it represents a triumph of the safety motive, which seeks to keep one safe and secure in the familiar role of childhood rather than insecure and therefore possibly unhappy in the role of an adult.

Often an attempt is made forcibly to crowd sex out of the mind, to refuse it any consideration. Sex is a reality which must be faced, like all other realities. It should be frankly admitted that sex is a major force in life, and a valuable one. It is of value primarily as a means of procreation, but it also is of value to individuals. Most of the greatest satisfactions of life come about through the exercise of the sex functions—in love for the mate and in bearing and rearing children. Sex is not low and unworthy except when it is made so by a low and unworthy person. There is nothing higher than the mating relationship, and all that it implies, when it is on the high level of high-minded persons.

Solution of Conflict.

As has been suggested, sex conflicts arise between the sex impulse and the ego and the social impulses. Most individuals solve these conflicts by bringing in a fourth combatant—the conscious mind. With its faculties of discrimination and judgment, it surveys all the other wishes and the various possible courses of action, and usually it allies itself with the social impulse and the super-ego in opposition to sex expression outside marriage.

The next step is for the conscious mind to find a method whereby its conclusion can be acted upon and sex be kept under control. Intelligent and discriminating persons usually find that the methods mentioned in the next three sections are of use in the control of sex.

Personal Intimacy.

Caresses are biologically the preliminary steps toward mating, and logically lead up to it. Any forms of personal contact may or may not be caresses, according as they do or do not spring from sex or arouse it. Young people often maintain that a kiss is "nothing," and to be sure it may be nothing for one of the two—but if it is in any way sensual to either, it is a caress and not a formality. Since caresses have one biological purpose—that of arousing sex—it should not be a matter of surprise that they often do precisely that, very promptly and to the ultimate degree. That the border is so narrow between what is intended and what is emphatically not

intended may not be recognized, especially by girls, whose emotions are usually, with respect to sex, less easily aroused than are those of men. Quite without any anticipation of such excitation, an individual may suddenly be overcome by it—unable, and indeed no longer wishing, to turn back. It does not do to take too much emotional security for granted in one's self or others.

Apart from the strain that petting places upon emotional control, it should be mentioned that it may be a strain on the nervous system and the reproductive organs if sex relationships are too often approached and then denied. The possibility of infection through promiscuous petting has been mentioned elsewhere.

Environmental Assistance.

The social conventions of former times that restricted the association of young men and women were perhaps based upon too much fear, which magnified the biological and social dangers. On the other hand, the widespread lack of conventions today is certainly based upon bravado, which minimizes those dangers. Often the bravado is based upon naivete due to lack of knowledge of human nature; more often, upon an equally naive belief that any difficulties that might arise could be easily controlled.

It is not the mark of a suspicious or timid mind, but of an enlightened one, to recognize and forestall situations that invite intimacies. Without being at all fanatical about it, it is safer to keep out of harm's way. To be sure, avoidance of danger is a negative sort of protection, but all sorts must be used when, at best, self-mastery is none too easy.

To avoid having to make decisions anew on every occasion, it is desirable to establish a set of conventions to be used automatically as an aid to maintaining one's chosen line of conduct. Such conventions should be established on theoretical grounds, before unfortunate experiences have shown the need of them.

It should be noted that the conventions are for the sake of conduct but also for the sake of reputation—and the young woman is indeed naive who thinks that a suspicion of laxity regarding sex does not injure her reputation in the eyes of the very ones whose respect she would most like to have.

Alcohol as a Complication.

Indulgence in alcohol has two effects that complicate many social situations; the senses are more easily aroused, and at the same time judgment and control are weakened. Behavior that would not be contemplated at all under ordinary circumstances

is likely, after taking even a small amount of alcohol, to seem either harmless or perhaps desirable. Therefore those who seek to keep on an even keel in regard to sex would do well to forego alcoholic beverages themselves and to avoid association with those who because of alcohol are temporarily over-sensual and under-restrained.

Social Technique.

Having established a border beyond which one does not intend to cross, not approaching this border too closely is largely a matter of skillful social technique. Every grown person should make it a matter of pride to be able to have pleasant association with those of the opposite sex and to keep it on the level he or she prefers. That ability is what constitutes a man or woman "of the world." It is that more than anything else which is implied in the term sophistication. The ability to stir up trouble is biologically inherent in male and female, and should not be taken to mean unusually captivating charms. Anyone can start trouble; not everyone can keep it from starting. The correct technique does not include prudishness in manner nor any unpleasant behavior that will offend and repel those whose friendship is worth having. It will not lead to unpopularity; even young people, except those who are sensuous and selfish, will not think less of another person who excludes sexuality from friendship, and puts agreeable companionship in its place.

Substitution.

In many normal young people the great force represented by the sex instinct does not cause any particular difficulty, because they learn quite naturally how to direct it and control it in ways that are approved by the intellect. This is especially true in the case of those who have learned to look at all sorts of problems squarely, not shying away from facts. It is also true in the case of those who have learned to restrain various other sorts of impulses, for the good of themselves or of those about them, and have not become accustomed to having all their desires of all sorts immediately gratified. This sort of training, even though begun late, gives much assistance in the training of the sex impulses.

When giving up one desire, the natural thing is to put another in its place. It is a matter of common observation that one can usually substitute one goal for another without any great loss of euphoria. Many do this unconsciously, and in lieu of unacceptable sex interests find many other interests and pleasures with which to

fill their time, engage their minds, and use their energies. The principle of substitution is that one cannot attend to two interests at once—either inevitability or expediency being the criterion in choosing which shall be given attention.

Sublimation.

Although simple substitution may serve to divert attention from sex, sublimation offers the only entirely satisfactory means of coping with the sex instinct under circumstances when the intellect directs that it should not be used in native ways.

Sublimation involves not merely expediency, but the symbolic gratification of a wish on a level that is *personally and socially more acceptable at the time and under the circumstances.* All the energy of the primary wish is utilized, but in the pursuit of the symbolic rather than the primary goal.

Sublimation often takes place more or less automatically, the individual not being fully aware of sex impulses nor of the methods whereby he sublimates them. More often, sublimation occurs as a result of the individual's finding out for himself that merely keeping himself occupied and casually interested in other matters is not enough, but that he must adjust in more fundamental ways to his impulses. Frequently much thought is necessary to the establishment of an adequate sublimation and to its subsequent maintenance.

Sublimation usually takes place along several lines.

First, the love aspects of sex may be symbolized in other sorts of love. It is possible to sublimate the most intense love for an individual, for love is not love unless it extends far beyond sex. Even in the marriage relationship the instinctive is for the most part submerged by the idealistic. The sublimation of love is indeed its greatest glory.

Love for other persons then the beloved may also be part of the irradiation of sexual love—for example, love for old persons and for children and for the unfortunate.

For complete sublimation it is often necessary to open one's heart to the whole world, and to love all mankind. Many of the happiest and most successful people realize quite well that humanity is receiving the devotion that in other circumstances might have had one person as its object. And the love of one person may still be the flame that illumines life, even though that love has been denied all but sublimated expression.

Second, the creative aspects of sex may be symbolized by creative work, the "child" of one's brain or hands. The wish for achievement

is an ego wish, but it may be rather definitely symbolic of sex wishes, in that it, too, involves creation. Work which is undertaken as sublimation must be such as to involve the use of one's best efforts and be truly representative of one's best self. But it may be any kind of work; it is not only the sort that is commonly known as creative work—art, music, literature, invention, and the like—that can be representative of one's self. Any work done with the force of the whole personality and powers behind it is creative work, and offers a channel for what might otherwise be the dangerously pent up, or perhaps inadequately pent up, force of sex.

Third, the social aspects of sex, normally expressed through fulfillment of the social need for perpetuation of human kind, may be symbolized by another sort of tribute to human welfare. The fullest sublimation will look not only to the self and its personal relationships and its accomplishments as such, nor even to mere social acceptability, but will also look to social value. It will mean being of use in the world—a principle that is psychologically as sound now as it has long been ethically sound. It is interesting to note that traditional ethics and the most modern psychological principles so often arrive at the same point.

To summarize: those who have many interests in common with many people and care much for others, on a non-mating basis whenever and for as long as it is necessary; who put all of themselves into whatever they do and get pleasure from both work and play; and who try to be of service to others and to the situations in which they find themselves, should not be unduly disturbed by sex emotions. They will wish for life in all its variety, but will miss nothing of the fullness of life, even though some of its experiences are denied them.

Chapter 49

THE SOCIAL IMPULSE

Biological Basis.

The individual multicellular organism, with the ability to use muscles and mind for adaptation, is in a favorable position for survival, but it can make its position still more favorable if it can establish friendly and helpful relationships with others of its kind.

Many species of animals that formerly inhabited the world are now extinct for one reason or another, but some species have been greatly aided in survival because they developed a most successful means of adaptation—that of banding together for mutual aid and protection. In such species, the individuals live in groups and cooperate in certain tasks (e.g., wolves hunt in packs). Among some species (e.g., bees; termites) survival is still further promoted by a division of labor.

When individual organisms pool their interests and establish division of labor, *relatedness* increases among them, and each individual organism becomes a unit of a larger unit—the *social organism*. The principle is exactly parallel to the banding together of the cells in the body, whose relatedness each to each is the basis of their life, and whose cooperation is the main determining factor in their increased chance of survival.

Man has established relatedness in all his affairs to such an extent that one individual would find it difficult even to try the experiment of living quite independently, to say nothing of carrying it through successfully. The things that he would have to do without, if he ceased to be dependent upon his fellows, would prove his undoing in a short time.

To understand the nature of the social impulse as it appears in man, further comparisons may be made between the life of the individual cell and the body it composes.

Just as each single cell in man's body affects all other cells and is affected by them, so each human affects the social organism and is affected by it.

Just as some of the energy of his unit cells must be used for their own upkeep and some for the upkeep of the whole body, so must

some of each human's energy be used for himself and some for the group of which he is an integral part.

Just as the cell's individual use of energy must be in harmony with that of all the other cells, so must the "selfish" activity of a human be in harmony with that of other humans; an ego each must be, but a social ego.

Finally, just as each unit cell in his body profits by the welfare of the whole body, so he, a social unit, profits by the welfare of society in general.

However it came about, we do live in relationship with others; and whether or not we wish to influence others, we do, and are influenced by them. And whether or not we wish to consider others, we *must*—or with them face failure and extinction. The social impulse, with its leading toward social coordination, has a sound biological basis.

Social Traits.

The necessity of association and coordination has endowed human beings with certain characteristic traits. Humans "naturally" want to be together; they are gregarious, and this extends through all phases of human life. Humans like to do things together, to form themselves into organizations, to be like each other, to think alike, to be approved by others, and, finally, to serve others.

These tendencies, in their manifold manifestations are capable of leading humans to the highest level of adaptation to life, and the highest happiness. Even in lesser ways, they are the source of much of man's development and his every-day satisfactions. At the worst they may be as destructive as any tendencies man has. The tragedy, however, is the absence of the social impulse—its failure to unite the individual in any bonds to his fellow creatures.

The Propinquity Motive.

The most obvious manifestation of the social impulse is the desire of humans to be near to each other. The vast proportion of the 135,000,000 persons making up our population lives in cities, towns or villages. In cities, millions may live on a few square miles of land. In buildings, a hundred homes may stand on an acre lot. Even within homes, rooms more often contain two, or more, than one. Families habitually gather in a common "living room." In college dormitories, it is reported that 85% of the rooms are double rooms, because most students prefer sharing a room with someone else, even though the cost is the same for a private room. Except in small commercial areas in cities, three-fourths of the telephone calls are

for "visiting" rather than for business. In prisons, solitary confinement is so severe a strain on a prisoner that it cannot be maintained for long without danger of deranging his mind.

In some cases, the native wish to be with others is too heavily accented. Even a few minutes alone may plunge such a person into misery, the worst dysphoria for him being that of loneliness. Others appear not to feel the need for companionship so keenly. Or perhaps they deliberately deny it for practical reasons such as obtaining time to work. Without lacking other manifestations of the social impulse, one may not crave a great deal of association with others in every-day life and still be quite normal. However, the more extreme "solitary"—the hermit type—is generally considered, and often is, somewhat abnormal. Certainly the normal individual seldom either fears or craves solitude, but enjoys the society of others and likes to be in groups, but also likes his own company at times.

The Organization Motive.

Human organizations, ranging from the small boy's "gang" up to the United States, represent the human desire to do things together. Beginning early in life the individual finds himself banded with others of his kind in most of his activities. Our civilization is based upon the principle of group organization. We have *political* organizations—official groups such as nations, states, cities, and the divisions and departments of each, and non-official political parties, with smaller party organizations in every town; and we have *educational* organizations—the public school system, and the privately organized colleges and schools, for the young from two years up; *religious* organizations; *scientific* organizations; *social* organizations; et cetera—all of these organizations existing because of man's innate preference for acting with others.

Groups are organized on many bases. The simplest is that of kinship of tastes and interests, such as underlies a bridge club or a mountain-climbing club. With many organizations, the reason for their existence is that certain things must be done, and they can be done more efficiently and economically by joint action. Surely a school system is a more effective way of educating 10,000,000 children than 10,000,000 private teachers would be. Similarly, an army for defence or attack is more effective than an equal number of individual soldiers.

A great many organizations exist for the purpose of advancing civilization in one way or another. An individual who has a social

aim gathers together those with similar aims, and the solidarity of each such group gives it greater strength than the sum of the individuals composing it. There are organizations that have weight and influence in almost every sphere of activity.

The normal person allies himself with organizations of many kinds because he likes the groups and feels akin to them, because he appreciates the social function of the organizations and wants to share it, and because he likes "team work."

When not guided, the "belonging" tendency may govern behavior disadvantageously. For example, it may produce the "joiner" type, male or female, whose leisure time is a round of clubs having no great value to the individual or to anybody else except that they bring people together who need to feel togetherness and cannot or do not find any significant basis for cohesion. Or it may produce the type of person commonly known as exclusive; one organization or group to which he belongs represents the fulfillment of all the social impulses for him, and he does not recognize any other groups as worth consideration. In this way, the tendency to form exclusive groups may be against the interest of society as a whole, since the more closely bound to each other the individuals are, the more the likelihood of hostilities and aversions to other separate groups.

When sublimated, the social impulse leads toward the union of the individual with organizations of the widest scope and the greatest significance to him and to his fellows. Such a group may not be large, but it will represent something socially large, in the sense that it is socially constructive, not disruptive. Such qualifications may be possessed by group activities organized for recreational, business, professional, or any other purpose.

The Conformity Motive.

In spite of a strong ego desire to be himself nearly every human also has a desire to be like others—others of his own personal group thrown together by propinquity or chance, or others of a chosen group, chosen either because they were like him at the start, or represent what he wants to be.

It is, of course, easier to do as others do—to follow the crowd; it saves the labor of making personal decisions. But the root of the desire for conformity is in the euphoria that comes from a *sense of harmony* with others. To conform to group standards cements our union with the group; we "belong" and expect to continue to belong as long as we continue to conform. We are spared any painful

criticism or ridicule, and we gain, as we hope, the approval of those whom we resemble.

The desire for conformity exhibits itself in three major ways. First, we seek conformity in *externals*—such matters as style in clothing and hair dressing, cars, houses, interior decorations, and the like. Frequent changes of style furnish an opportunity for the individual to obtain repeated evidence that he is still eagerly following the group, and belongs to it this season just as he did last.

Conformity in externals is a great comfort to many an individual, but also it may be a source of misery if he cannot conform as fully as he would wish, or if he sacrifices too much else to his need for conformity—for example, his financial security. It is a notable fact that the ego will give up many of its demands for the sake of the euphoria that comes from even this lesser evidence of kinship with one's kind. Regarding esthetics as expressed in personal adornment, for example, the ego may gladly give up its desire for beauty if only the conformity motive can be gratified.

To be "different" in respect to externals, especially of appearance, places a person under suspicion. A man who wore a straw hat all winter would certainly be considered "odd," to say the least. His doing so might indeed represent an extreme reaction against following the social impulse, and it might be a symptom of a diffuse failure to balance his ego impulses with his social impulses. Yet it might be his one gesture of independence.

Second, we desire conformity in *manners*. In this sphere, conformity is certainly highly desirable. In any epoch, good manners are the manners of a person of fine nature—they comprise the way such a person naturally behaves. More people appreciate such manners than can spontaneously exhibit them. Therefore, parents in all lands always consider it important to bring up children to have the manners of naturally well-behaved persons. This tendency to respect the best in manners and to emulate it, leads to a smoothness in social intercourse that would otherwise not exist. It is fitting indeed that those who are so uncouth that they would not have good manners of their own initiative, and would go about making themselves objectionable to those of good taste, should strive to the utmost for conformity with the approved standards. Mrs. Emily Post's book on etiquette has made many an otherwise boorish person tolerable. It is better to ape good manners than not to have them.

However, the letter of the law rather than its spirit may become a fetish with those who feel no assurance within themselves. Some would almost rather be caught stealing than using the wrong fork at dinner. A girl dismissed a young man in hauteur because he

failed to rise when she entered the room for the fifth time in an hour. Many young people never introduce anyone to anyone else because they are afraid that they will not do it correctly.

Dean Swift once observed: "Good manners is the art of making those people easy with whom we converse. Whoever makes the fewest persons uneasy is the best bred in the company."

Third, there exists in most humans a desire for conformity to the *opinions* of others. In spite of cherishing most highly the wish to use our own brains and to do our own thinking, most of us, in many respects, large and small, are compellingly drawn toward agreement with our group. This has its root in the obvious advantage in group life of unanimity of opinion among its various members. It makes for united action against any common foe and it promotes comfortable living within the group.

The major matters upon which society as a whole has opinions are those regarding the *behavior* of individuals with reference to other individuals and in reference to group welfare. It is these opinions in particular with which individuals as a rule feel compelled to conform.

Mores and Laws.

A social organism has its own life to protect, and it must have the cooperation of its unit members. Just as the human body will be destroyed if any of its groups of cells carry on independent activity not in accord with the whole body's needs (as in cancer), so will the social organism be destroyed if its individual members become, like cancer cells, asocial or antisocial.

From earliest times in history there has existed in every group a force that may be called *public opinion.* It represents the crystallized sentiment of the group regarding what is good for it and what is not—what individuals may do and what they may not. Primitive peoples everywhere have their accepted ways of behavior. The Latins used the term *mores* to describe the customs and habits, manners and ways of life that were common to the group. The term survives in our word morality, which implies right ways of behavior—the sort of behavior that is for the social welfare.

In order to have no misunderstanding about the sort of behavior that was not acceptable, the human race early began to record some of its established standards as laws. Many of the first recorded laws for the regulation of human conduct are still the laws of the civilized world.

Today, public opinion is expressed in the same two ways as of old—the mores, or *unwritten* but established and binding customs

regarding relationships between individuals and of individuals to society as a whole; and the mass of *codified* laws and statutes, and the common law. As of old, the written and unwritten rules of behavior represent what society believes to be to its best advantage. Individuals making up the group normally recognize that what is good for the whole group will indirectly confer benefits upon themselves, and tend to listen to whatever is clearly the voice of society as a whole, and to follow its guidance.

Enforcement of Social Standards.

Society requires that there be conformity to written laws, and provides penalties for non-conformity. Such penalties are in the nature of punishment to the wrong doer, but the statement of what the penalties will be has undoubtedly always been intended primarily to act as a deterrent. They call attention to what society believes individuals should not do. Those who have little feeling for society's welfare are thereby shown what the current social standards are, and how important they are considered.

As for the unwritten laws, society relies upon the fact that the majority of individuals find it unbearable to be out of harmony with their group, and dread being socially frowned upon almost as much as they dread incarceration. Just how unbearable it might be to be shut out from one's kind has been vividly portrayed by Edward Everett Hale in "The Man without a Country." Even in childhood, trivial experiences of exclusion early give a clear concept of what it would be like to be completely excluded. It is said that in the Army there is no more severe punishment than that of being "sent to Coventry"—allowed to mingle with others but being ignored by them.

Most of the unwritten laws can safely be left for their enforcement to informal action by the group, through some form of ostracism or exclusion from the groups representing public opinion. Many of the most important matters of social welfare are governed in no other way. Such is the case, for example, with respect to general ruthlessness; society can never legislate against it, and can only express its disapproval—unfortunately not always clearly enough to turn the ruthless into the kindly. Society can, however, stand behind its organizations (religious, educational, medical, etc.) in their efforts to accomplish that result.

Minority Standards.

In the total society there are groups within groups, and any given individual may be deafened by the clamorous voice of his

own group and fail to hear that of the larger group, or of humanity as a whole. The smaller group opinion may not be representative of the whole of society, nor even of any large part of it—indeed popular thought within it may be completely asocial, as in some neighborhood cliques and some "social sets," and in groups working entirely for their own interests, albeit within the law; or antisocial, as in the criminal gang. For many individuals, what is "done" or "not done" in one's immediate circle furnishes the chief standards of behavior; and the fear of "getting in wrong" or being "cut" or "black-balled" or receiving "the cold shoulder" from these asocial or antisocial groups is the chief force compelling conformity.

There is another side to the matter however; throughout history, minority groups within society have repeatedly gone ahead of the majority in recognizing social needs, and have led it toward higher standards. Many groups—religious, scientific, educational and cultural—have to their credit an unremitting pull upon society as a whole to higher levels than those already attained.

The Validity of Social Standards.

The question naturally arises in the mind of every thinking person, do current social standards at any given time represent society's real needs? In other words, is the biggest opinion the best opinion?

Those who are capable of appreciating differences in quality of opinion will not be satisfied with conformity to any small nondescript group, nor indeed to any but those of a superior group. But in judging the quality of an opinion, the number of people who hold it is likely to weigh in its favor with them—especially when it is an opinion that has long been steadily held and not seriously challenged. An example might be the public opinion regarding sexual promiscuity. Another might be the public opinion in democratic countries that endorses that form of government.

Certainly all standards are open to question, and must be questioned if civilization is not to remain static. Nevertheless, at any given moment public opinion in any given country represents the nation thinking and feeling as a mass; and that composite opinion is certainly worth consideration. Because it is made up of individual opinions, it will be no higher than the highest individual opinion, and according to mathematical expectation, it would be no higher than the average. However, that does not always turn out to be the case; indeed group opinion may represent a standard that is far beyond the attainment of the majority. The democratic ideal, for

example, certainly is a popular goal which is still scarcely appreciated, to say nothing of attained, by the majority.

Society is not always *behind* its advanced thinkers—for example, the American public as a whole went every inch of the way with Adams and Lee, Jefferson and Franklin and the others in producing the Declaration of Independence. On the other hand, society cannot always keep *ahead* of its unthinking members, those of more primitive feeling, who may so inflame the emotions of the whole group as to produce action not approved in sober moments. James Madison in his "Federalist Papers" said, "In all very numerous assemblies, of whatever character composed, passion never fails to wrest the sceptre from reason. Had every Athenian citizen been a Socrates, every Athenian assembly would still have been a mob." The implication is that passions are to be contrasted with wisdom; that is, of course, not the case. Passions represent driving force, and they may drive toward good ends or bad.

Clearly, the biggest group opinion is not necessarily the best nor yet the worst. Individuals at the highest level of development will sometimes find current standards not high enough; those at lower levels will find them too high. The former will make their adjustments to the social impulse at a level beyond that which society requires of them; the latter, those who have not yet caught up with the march of social progress, will do well if they conform even to the more moderate standards of their times.

The Social Impulse and the Ego.

Obviously there are the elements of mental conflict in the fact that ego impulses and social impulses may pull with equal strength in opposite directions. The social need to act with others is matched by the ego need for independent action; therefore we have two tendencies, to *keep with the group* and to *leave the group*. The social need for being in harmony with others is matched by the ego need for individuality; therefore we wish to *be like others*, and to *be different*. The social need of working for the group is matched by the ego need of working for one's self; therefore we have tendencies to *be selfish* and to *be unselfish*. Every slightest ego wish may be matched by a social wish counterbalancing it. Conflict invariably ensues, and must be solved.

At first, in childhood, the most vociferous demands are likely to come from the ego, but the child normally begins to develop affection for and interest in those near at hand, and to be more and more stimulated by motives springing from his social relationships. All

normal persons in the course of their development tend to have a constantly increasing feeling for others, and an increasing tendency to try to harmonize their personal wishes with those of their associates.

In a normal environment and with favorable training, an individual can hardly fail to experience the euphoria that comes through acting suitably upon his social impulses, and eventually to seek satisfaction of them as well as the satisfaction of ego wishes. When normally balanced, the individual says "We" as often as he says "I." He is happy in being with others, but he is also happy alone. He likes to be like others in ways that make for comfort and harmony, but he also likes to be himself at his best. He likes to be in agreement with others whose opinion he respects, but he is willing to do his own thinking and stand by his considered judgments. He is willing to work for group interests as hard as he works for his own good—and to pull his share of the load in any group untertakings. He thinks of the rights of others as often as of his own, and surrenders his own rights when asserting them would harm his associates.

Defective Social Impulses.

It is believed that the social impulse is present in all normal individuals having normal experiences. However, in some persons it appears to be absent in spite of circumstances that normally awaken it. Or, if awakened at all, it may express itself in the most rudimentary and superficial fashion in support of the ego rather than in opposition to it. For example, it may make a person "sociable," but chiefly for the pleasure it gives him.

All our social institutions and our mental hygiene are based upon the assumption that the social impulse is actually present and can be developed to be a counterbalancing force in the personality, checking and directing the responses to the ego impulse and the sex impulse. It appears, however, that whether by inborn nature or by acquired defect, there are among us many personality cripples, lacking the force of any strong feeling for others. Possibly we shall not solve some of our social problems until we recognize that even those who are normal in intelligence may be deficient—and perhaps hopelessly so—according to personality norms.

Those lacking a developed social impulse constitute the greatest drag on civilization. At best, such a person is *asocial*, neither for nor against the social welfare, but virtually against, since he is not for. At worst, he is *antisocial* and turns his hand against society in

criminal acts, or he becomes *mentally ill.* It is perhaps lack of social feeling more than anything else that distinguishes the mentally ill from the mentally well.

Nevertheless, it can never be certain in the case of a child how far he can develop until every effort is made to discover early signs of faulty development and to correct it.

It should be suspected that a child is not developing due social feeling (*a*) if he wishes always to play by himself; (*b*) if, when he does play with others, he must always dominate them; (*c*) if he feels that he is "different," and better than others; (*d*) if he feels that he has special rights; (*e*) if he becomes at odds with the group and feels that it is against him; and (*f*) if he manages to set members of the group against each other, or the group against other groups.

Also, the normality of development should be questioned if a child, although highly "sociable" and gregarious, does not sense anything of the contribution that others have made and are making to his welfare, or the contribution due from him to others—in other words, if he does not acquire the concept of "give and take," but only of "take."

Sublimation of the Social Impulse.

At his highest level of development, the individual identifies himself not only with those near him, but with the social organism as a whole—with all humanity. He sees himself as he really is, a self among other selves, but not a separate self. He and humanity are one. And his self gains dignity and worth from this concept. His ego yields its demands to a super-ego identified with all mankind. Conflict no longer exists, for what the self wants is what the social organism wants. Life at last becomes "plain sailing" and all the energies may be used in navigating toward a clear goal.

One of the best examples in all literature of the sublimation of ego and social impulses, and their harmonizing as one impulse, is the life of Pierre and Marie Curie, who labored endlessly using their great powers in work that at one and the same time was fulfillment of themselves and fulfillment of the needs of mankind.

It is not within the power of many individuals to give to humanity as did the discoverers of radium; yet society needs to have each of its members fulfill his own destiny in the same spirit of accord with the common good. Whatever a person's level of *ability*, there can be no question that his level of *adaptation* is the highest when he sees himself and mankind as one, and acts for his fellow man as for himself.

It should be noted that this conclusion regarding adaptation to life, reached through the study of psychobiology, corresponds closely with that reached through the study of ethics and religion.

The Socially Minded.

In every-day life among every-day mortals, the socially minded person will wish to *observe the laws* of his land, believing that on the whole they are fair to all. He will desire to *advance group interests* and to *promote social welfare* in any ways within his power. He will be interested in, and have a part in, *public works* of various kinds (education, public health, etc.) and in *group organizations* representing humanity striving for high aims (religious, political, charitable, etc.). His interest in the public good will not be theoretical and remote, but practical and near at hand. He will do, as well as dream; and he will do what is up to him to do, even though his part is not large and conspicuous.

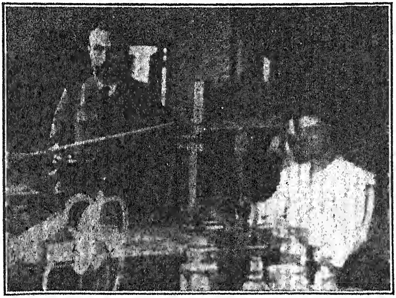


FIG. 183.—Pierre and Mme. Curie in their Laboratory. (From Mme. Curie's "Pierre Curie," By Permission of The MacMillan Company Publishers.)

He will be a *good citizen*. He will help to run his community and nation by means of the ballot, and his vote will not be based upon rumors and propaganda and prejudice, but upon all that he can learn from direct sources (e.g. the platform of the various political parties, not only his own). He will be a *good neighbor*, sportsmanlike in suppressing his own interests if they conflict with those of others (e.g., he will keep his radio turned low, and keep his sidewalk free from ice in winter, etc.). Last but not least, he will be a *good friend*, and in his own sphere try to promote kindly relations and harmony among his fellow men.

All these things the socially minded person will do not only because he thinks it is his duty, but because he will not be comfortable unless he does them, and because he will be extraordinarily content if he does.

It is obvious that there is a vast difference between the blind and heedless follower of the herd's more superficial wishes and the one who tries to learn and to follow the spirit of the social impulse, which is, in little and big ways, each for all and all for each. The foundation of mental health is the recognition of the greatest reality of all—the brotherhood of man.

APPENDIX

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS

Abstracted from tables by Atwater and Bryant, as given in Bulletin No. 28, United States Department of Agriculture, Office of Experiment Stations. Starred items are from table by Woods, as given in Farmers' Bulletin No. 34, United States Department of Agriculture. The figures given are for average composition. In their natural state, various specimens of a given food differ somewhat in composition, and different methods of cooking or processing may cause marked differences.

(Decimal fractions have been omitted except in the case of the percentages under six. In other cases the nearest whole number has been used.)

Food material	Water, percent	Protein, percent	Fat, percent	Carbohydrate, percent	Mineral ash, percent	Fuel value per pound
Animal Food						
Meat						
Beef; roast	48	22	29	....	1.3	1620
sirloin steak	64	25	10	....	1.4	875
corned beef	54	15	26	....	4.9	1395
dried, smoked, salted	45	39	5.4	....	11	960
tongue	51	19	23	....	4	1340
Veal; leg, roast	72	21	7	....	1.1	670
calf's liver	73	19	5.3	....	1.3	575
Lamb; roast	67	20	13	....	.8	900
chops	48	22	30	....	1.3	1665
Mutton; leg, roast	51	25	23	....	1.2	1420
Pork; chops	51	16	32	....	.9	1655
loin, roast	66	19	13	....	1	900
boiled ham	51	20	22	....	6	1320
fried ham	37	22	33	....	6	1815
bacon	20	10	65	....	5.1	2930
sausages	40	13	44	1.1	2.2	2125
Frankforters	57	20	19	1.1	3.4	1170
Chicken; broiler	70	21	8	....	1.1	890
canned, boned	58	28	13	....	2.2	1245
Turkey; roast, dark meat	54	39	4.3	....	2.2	1200
roast, light meat	58	35	4.9	....	1.8	1090
Fish						
Bluefish	78	19	1.2	....	1.3	410
Cod, fresh	80	19	.5	....	1.2	370
Cod, salt, boneless	55	27	.3	....	19	490
Haddock	82	17	.3	....	1.2	335

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS. (*Continued*)

Food material	Water, percent	Protein, percent	Fat, percent	Carbo-hydrate, percent	Mineral ash, percent	Fuel value per pound
Fish, cont'd						
Halibut	75	19	5.2	....	1	565
Herring, fresh	72	19	7	....	1.5	660
Herring, smoked	35	37	16	....	13	1335
Mackerel, fresh	73	19	7	....	1.2	645
Mackerel, salt	43	17	26	....	13	1435
Salmon, fresh	65	22	13	....	1.4	950
Salmon, canned	63	22	12	....	2.6	915
Sardines, canned	52	23	20	....	5.6	1260
Shad	71	19	9	....	1.3	750
Shad roe	71	21	3.8	....	1.5	600
Trout	78	19	2.1	....	1.2	445
Shell fish						
Clams	81	11	1.1	5.2	2.3	340
Crabmeat, canned	80	16	1.5	.7	2	370
Lobster, whole	79	16	1.8	.4	2.2	390
Lobster, canned	78	18	1.1	.5	2.5	390
Oysters	88	6	1.3	3.3	1.1	230
Scallops	80	15	.1	3.4	1.4	345
Dairy Products, etc.						
Milk, whole	87	3.3	4	5	.7	325
Milk, condensed, sweetened	27	9	8	54	1.9	1520
Buttermilk	91	3	.5	4.8	.7	165
Cream	74	2.5	18	4.5	.5	910
Butter	11	1	85	....	3	3605
Cheese, American	32	29	36	.3	3.4	2055
Cream	34	26	34	2.4	3.8	1950
Roquefort	39	23	29	1.8	7	1700
Eggs, whole	74	13	10	....	1	720
whites	86	12	.2	....	.6	250
yolks	49	16	33	....	1.1	1705
Oleomargarine	9	1.2	83	....	6	3525
Gelatine	14	84	.1	....	2.1	1705

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS. (*Continued*)

Food material	Water, percent	Protein, percent	Fat, percent	Carbo-hydrate, percent	Mineral ash, percent	Fuel value per pound
Foods from the vegetable Kingdom						
Cereals, etc.						
Oatmeal	84	2.8	.5	11	.7	285
Hominy	79	2.2	.2	18	.5	380
Macaroni	78	3	1.5	16	1.3	415
Rice	72	2.8	.1	24	.2	510
Shredded wheat	8	10	1.4	78	2.1	1700
Bread, Pastry, etc.						
White bread	35	9	1.3	53	1.1	1215
Brown bread	44	5.4	1.8	47	2.1	1050
Gluten bread	38	9	1.4	50	1.3	1160
Whole wheat bread	37	10	.9	50	1.3	1140
Boston crackers	8	11	8	71	1.9	1885
Graham crackers	5	10	9	74	1.4	1955
Pretzels	9	9	4	73	4	1700
Cake, etc.						
Chocolate layer cake	20	6	8	64	1.1	1650
Fruit cake	17	6	11	64	1.8	1760
Sponge cake	15	6	11	66	1.8	1795
Doughnuts	18	7	21	53	.9	2000
Gingerbread	19	6	9	63	2.9	1670
Lady fingers	15	9	5	71	.6	1685
Macaroons	12	6	15	65	.8	1975
Pie						
Apple	42	3	10	43	1.8	1270
Custard	62	4.2	6	26	1	830
Lemon meringue	47	3.6	10	37	1.5	1190
Mince	41	6	12	38	2.5	1335
Raisin	37	3	11	47	1.5	1410
Squash	64	4.4	8	22	1.3	840
Pudding						
Indian cornmeal	61	5	5	27	1.5	815
Rice pudding	60	4	5	31	.6	825
Tapioca pudding	64	3.3	3.2	28	.8	720

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS. (*Continued*)

Food material	Water, percent	Protein, percent	Fat, percent	Carbo-hydrate, percent	Mineral ash, percent	Fuel value per pound
Sugars						
White sugar	....	....	....	100	....	1860
Maple sugar	....	....	....	83	....	1540
Maple syrup	....	....	....	71	....	1330
Honey	18	.4	....	81	.2	1520
Candy (average composition)	....	....	....	96	....	1785
Vegetables*						
Asparagus	94	1.8	.2	3.3	.7	105
Beans, string	89	2.3	.3	7.4	.8	195
Beans, Lima	68	7.1	.7	22	1.7	570
Beets	87	1.6	.1	10	1.1	215
Cabbage	91	1.6	.3	5.6	1	145
Carrots	88	1.1	.4	9	1	210
Cauliflower	92	1.8	.5	4.7	.7	140
Celery	94	1.1	.1	3.3	1	85
Corn, green, sweet	75	3.1	1.1	20	.7	470
Cucumbers	95	.8	.2	3.1	.5	80
Egg plant	93	1.2	.3	5.1	.5	130
Lettuce	95	1.2	.3	2.9	.9	90
Mushrooms	88	3.5	.4	7	1.2	210
Onions	88	1.6	.3	10	.6	225
Parsnips	83	1.6	.5	13	1.4	300
Peas, green	75	7	.5	17	1	465
Potatoes	78	2.2	.1	18	1	385
Potatoes, sweet	69	1.8	.7	27	1.1	570
Pumpkin	93	1	.1	5.2	.6	120
Radishes	92	1.3	.1	5.8	1	135
Rhubarb	94	.6	.7	3.6	.7	105
Spinach	92	2.1	.3	3.2	2.1	110
Squash	88	1.4	.5	9	.8	215
Tomatoes	94	.9	.4	3.9	.5	105
Turnips	90	1.3	.2	8	.8	185
Vegetables, canned						
Beans, baked	69	7	2.5	20	2.1	600

* In vegetables and fruits, part of the carbohydrate is cellulose, which does not add to the caloric value.

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS. (*Continued*)

Food material	Water, percent	Protein, percent	Fat, percent	Carbo-hydrate, percent	Mineral ash, percent	Fuel value per pound
Vegetables, canned cont'd						
Beans, string	94	1.1	.1	3.8	1.3	95
Beans, Lima	79	4	.3	15	1.6	360
Beans, red kidney	73	7	.2	18	1.6	480
Brussels sprouts	94	1.5	.1	3.4	1.3	95
Corn	76	2.8	1.2	19	.9	455
Peas	85	3.6	.2	10	1.1	255
Succotash	76	3.6	1	19	.9	455
Tomatoes	94	1.2	.2	4	.6	105
Olives, green	58	1.1	28	12	1.7	1400
Olives, ripe	65	1.7	26	4.3	3.4	1205
Fruits, fresh						
Apples	85	.4	.5	14	.3	290
Bananas	75	1.3	.6	22	.8	460
Blackberries	86	1.3	1	11	.5	270
Cherries	81	1	.8	17	.6	365
Grapes	77	1.3	1.6	19	.5	450
Huckleberries	82	.6	.6	17	.3	345
Lemons	89	1	.7	8	.5	205
Muskmelon	89	.6	....	9	.6	185
Oranges	87	.8	.2	12	.5	240
Peaches	89	.7	.1	9	.4	190
Pears	84	.6	.5	14	.4	295
Pineapples	89	.4	.3	10	.3	200
Plums	78	1	....	20	.5	395
Prunes	80	.9	....	19	.6	370
Raspberries	84	1.7	1	13	.6	310
Strawberries	90	1	.6	7	.6	180
Watermelon	92	.4	.2	7	.3	140
Fruits, canned*						
Apricots	81	.9	....	17	.4	340
Blackberries	40	.8	2.1	56	.7	1150
Blueberries	86	.6	.6	13	.4	275
Cherries	77	1.1	.1	21	.5	415

* Water-packed or juice-packed fruits contain less carbohydrate than the figures here given for fruits canned with sugar.

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS. (*Continued*)

Food material	Water, percent	Protein, percent	Fat, percent	Carbo-hydrate, percent	Mineral ash, percent	Fuel value per pound
Fruits, canned cont'd						
Orange marmalade	14	.6	.1	85	.3	1585
Peaches	88	.7	.1	11	.3	220
Pears	81	.3	.3	18	.3	355
Pineapple	62	.4	.7	36	.7	715
Strawberries	75	.7	....	24	.5	460
Fruits, dried						
Currants	17	2.4	1.7	74	4.5	1495
Dates	15	2.1	2.8	78	1.3	1615
Figs	19	4.3	.3	74	2.4	1475
Raisins	15	2.6	3.3	76	3.4	1605
Nuts						
Almonds	4.8	21	55	17	2	3030
Brazilnuts	5	17	67	7	3.9	3265
Butternuts	4.4	28	61	3.5	2.9	3165
Chestnuts	45	6	5.4	42	1.3	1125
Cocoanut	14	6	51	28	1.7	2760
Filberts	3.7	16	65	13	2.4	3290
Peanuts	9	26	39	24	2	2560
Peanut butter	2	29	46	17	5	2825
Pecans	3	11	71	13	1.5	3455
Pistachio nuts	4.2	22	54	16	3.2	2995
Walnuts	2.5	28	56	12	1.9	3105
Soups						
Beef	93	4.4	.4	1.1	1.2	120
Bean	84	3.2	1.4	9	1.7	295
Chicken	84	10	.8	2.4	2	275
Clam chowder	89	1.8	.8	7	2	195
Meat stew	84	4.6	4.3	5.5	1.1	370
Soups, canned						
Asparagus	87	2.5	3.2	5	1.4	285
Bouillon	97	2.2	.1	.2	.9	50
Celery	89	2.1	2.8	5	1.5	250
Chicken	94	3.6	.1	1.5	1	100

TABLE 1.—CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS.
(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Soups, canned cont'd						
Julienne	96	2.7	....	.5	.9	60
Mock turtle	90	5.2	.9	2.8	1.3	185
Mulligatawny	89	3.7	.1	6	1.2	180
Oxtail	89	4	1.3	4.3	1.6	210
Pea	87	3.6	.7	8	1.2	235
Tomato	90	1.8	1.1	5.6	1.5	185
Vegetable	96	2.9	....	.5	.9	65

Table 2.—100-calorie Portions

This table is based on the percentages given in Table I. Since there is some variation in the proportions of foodstuffs in given foods, and in the size of servings, this table cannot be considered entirely accurate. It is given here because it shows in a general way how much of the various sorts of foods, as served, will provide about 100 calories.

Meat and Fish

Sirloin steak	medium serving
Tenderloin steak	small serving (2 × 1 × 1 inches)
Hamburg steak	1 medium cake
Roast beef	small serving (4 × 2 × 1/4 inches)
Filet of beef	small serving
Corned beef	small serving
Beef loaf	medium slice
Tongue	small serving
Dried beef, creamed	1/3 cup
Veal, roast	medium serving
Lamb, roast	medium serving
Lamb chop	small chop
Pork, roast, lean	medium serving
Ham, boiled	small serving
Ham, roast	small serving
Bacon, fried	4 or 5 small slices
Frankforters	1
Chicken, roast	medium serving
Chicken, creamed	1/4 cup
Turkey, roast	small serving
Duck, roast	small serving
Bluefish	large serving
Cod	large serving
Haddock	large serving
Halibut	large serving
Mackerel	medium serving
Salmon	medium serving
Sardines	3–6
Fish cake	1
Lobster	3 heaping tablespoonfuls
Lobster, canned	3/4 cup
Clams	12 medium
Oysters	12 small
Scallops	2 heaping tablespoonfuls

TABLE 2.—100-CALORIE PORTIONS.—(*Continued*)

Eggs	
Raw or cooked	1 very large 1⅓ medium
Vegetables	
Asparagus	20 stalks
Beans, baked	⅓ cup
Beans, string	2 cups
Beets	1⅓ cups
Cabbage, shredded	5 cups
Carrots	1½ cups
Cauliflower	small head
Celery	1 bunch
Corn, canned	⅓ cup
Corn, on cob	2 small ears
Cucumbers	3 medium
Lettuce	2 large heads
Macaroni	2 servings (1 cup)
Mushrooms	12 medium
Olives	6–8
Onions	3 to 4 (2 servings)
Parsnips, creamed	2 servings
Peas	¾ cup
Potatoes	
boiled	1 large
baked	1 large
mashed	½ cup
sweet	½
Radishes	36
Spinach	2½ cups
Tomatoes	
canned	1¾ cups
stuffed	1
fresh	4 medium
Turnips, creamed	2 servings
Cream sauce	⅓ cup
Fruits	
Apple	2
Apple sauce	⅜ cup
Apricots (canned)	3 halves with 2 tablespoonfuls juice

TABLE 2.—100-CALORIE PORTIONS.—(*Continued*)

Fruits, cont'd	
Banana	1 large
Blackberries (fresh)	½ cup
Blueberries (fresh)	1 cup
Cantaloupe	1 melon (4½″ diameter)
Dates	3 large
Figs	1 large
Grapes, Concord	1 large bunch
Orange	1 very large
Peach	3
Peaches (canned)	2 large halves with juice
Pear	1 large
Pears (canned)	2 halves with juice
Pineapple (canned)	1 slice with juice
Prunes, stewed	3 medium, with juice
Raisins	¼ cup
Rhubarb, stewed	½ cup
Strawberries (fresh)	1⅓ cups
Cereals	
Cornflakes	1¼ cups
Grapenuts	3 tablespoonfuls
Oatmeal, cooked	1 cup
Puffed rice	1⅓ cups
Puffed wheat	1⅔ cups
Shredded wheat	1 biscuit
Dairy Products	
Butter	½ oz. or 1 tablespoonful or 1 large pat
Buttermilk	large glass
Cream	¼ cup
Cheese, American	1½″ cube
Cheese, cottage	4″ cube
Milk	small glass (⅝ cup)
Bread, Rolls and Crackers	
Bread, white	thick slice, medium size
Bread, whole wheat	thick slice, medium size
Bread, corn	2″ cube
Baking powder biscuit	2 small
Graham crackers	2
Oyster crackers	24

TABLE 2.—100-CALORIE PORTIONS.—(*Continued*)

Bread, Rolls and Crackers, cont'd	
Saltines	6
Griddle cakes	1 cake (4½″ diameter)
Corn muffins	¾
Popovers	1
French rolls	1
Club sandwich	⅙
French toast	1 slice
Waffles	½ waffle (6″ diameter)
Desserts	
Boiled custard	⅓ cup
Cup custard	⅓ cup
Ice cream, average	2½ heaping tablespoonfuls
Chocolate sauce	1 tablespoonful
Preserved fruit sauce, sweetened	2 tablespoonfuls
Sherbert and water ices	½ cup
Milk sherbet	¼ cup
Lemon jelly	½ cup
Coffee jelly	1¼ cups
Baked apple with sugar	½ large
Baked apple with cream	¼ large
Rice pudding	ordinary serving
Rice pudding with cream	½ serving
Blanc mange	ordinary serving
Apple pie	1½″ sector (diameter 9″)
Custard pie	2″ sector (diameter 9″)
Lemon meringue pie	1″ sector (diameter 9″)
Mince pie	1″ sector (diameter 9″)
Squash pie	2″ sector (diameter 9″)
Doughnuts	½
Gingerbread	2″ cube
Macaroons	2
Sponge cake	size of thick slice of bread
Fruit cake	thin slice
Fudge cake	slice 2 × 1 × 1 inches
Accessories	
Sugar	2 dominoes (2 tablespoonfuls)
Honey	1 tablespoonful
Maple sugar	4 teaspoonfuls
Maple syrup	1½ tablespoonfuls
Marmalade	3 teaspoonfuls

TABLE 2.—100-CALORIE PORTIONS.—(*Continued*)

Nuts	
Peanuts	10–12 double
Walnuts	8–16
Almonds	8–10
Peanut butter	2½ teaspoonfuls
Candy	
Fudge	1 large piece
Caramels	1″ cube
Chocolate peppermint	one medium
Foods as served	
Chicken salad	1 small serving
Fruit salad with French dressing	1 serving
Lettuce salad with French dressing	1 serving
Waldorf salad	½ serving
Mayonnaise dressing	1 tablespoonful
Olive oil	1 tablespoonful
Soups	
Bouillon	4 cups
Cream soup, average	2 plates
Bean soup	large plate
Prepared Dishes with Cheese	
Macaroni and cheese	½ cup
Welsh rarebit on toast	1½ tablespoonfuls with ½ slice toast
Beverages	
Cocoa average	½ cup
Egg lemonade	½ cup
Eggnog	½ cup
Fruit punch, sweetened	½ cup
Lemonade	large glass (1⅔ cups)
Orange juice	1 cup
Grape juice	½ cup

TABLE 3.—BRIEF LIST OF NATIONAL ORGANIZATIONS WORKING WHOLLY OR PARTLY FOR HEALTH (EXCLUSIVE OF GOVERNMENTAL ORGANIZATIONS AND OF PHYSICIANS' PROFESSIONAL ORGANIZATIONS)

Starred organizations are active members of the National Health Council, q.v.

American Association of Medical Social Workers. 84 Rush St., Chicago, Ill.
American Child Health Association. 50 W. 50th St., New York City
American Committee on Maternal Care. 5848 Drexel Ave., Chicago, Ill.
American Dental Association. 212 E. Superior St., Chicago, Ill.
American Foundation for Mental Hygiene. 1790 Broadway, New York City.
American Foundation for the Blind. 15 W. 16th St., New York City.
*__American Heart Association.__ 1790 Broadway, New York City.
American Home Economics Association. 620 Mills Bldg., Washington, D.C.
American Hospital Association. 18 E. Division St., Chicago, Ill.
American Institute for the Deaf-Blind. 2332 Bryant Ave., Evanston, Ill.
*__American National Red Cross.__ Washington, D.C.
(a)__American Nurses' Association.__ 1790 Broadway, New York City.
American Occupational Therapy Association. 175 Fifth Ave., New York City.
*__American Public Health Association.__ 1790 Broadway, New York City.
American School Health Association. Kent, Ohio.
*__American Social Hygiene Association.__ 1790 Broadway, New York City.
*__American Society for the Control of Cancer.__ 1250 Sixth Ave., New York City.
*__American Society for the Hard of Hearing.__ 1537-35th St. N.W., Washington, D.C.
American Student Health Association. Minneapolis, Minn.
Child Welfare League of America. 130 E. 22nd St., New York City.
Commonwealth Fund, 41 E. 57th St., New York City.
(a)__Foundation for Positive Health.__ 1790 Broadway, New York City.
Markle Foundation (John and Mary R.). 14 Wall St., New York City.
*__Maternity Center Association.__ 1 E. 57th St., New York City.
Milbank Memorial Fund. 40 Wall St., New York City.
*__National Committee for Mental Hygiene.__ 1790 Broadway, New York City.
National Council for the Physically Handicapped. 2102 West Pierce St., Milwaukee, Wisconsin.
National Foundation for Infantile Paralysis. 120 Broadway, New York City.
NATIONAL HEALTH COUNCIL. Organized to avoid duplication of effort in national organizations. Consists of 17 organizations as follows: the 11 active members starred in this list; the 2 associate members marked (a); 2 advisory members, the United States Public Health Service and the United States Children's Bureau; and the Conference of State and Provincial Health authori-

ties of North America and the National Committee of Health Council Executives. It maintains an information service and library. 1790 Broadway, New York City.

*National Organization for Public Health Nursing. 1790 Broadway, New York City.

National Recreation Association. 315 Fourth Ave., New York City.

National Research Council. Washington, D.C.

National Safety Council. 20 North Wacker Drive, Chicago, Ill.

*National Society for the Prevention of Blindness. 1790 Broadway, New York City.

*National Tuberculosis Association. 1790 Broadway, New York City.

Rockefeller Foundation. 49 W. 49th St., New York City.

Spellman Fund (Laura Spellman Rockefeller Foundation). 49 W. 49th St., New York City.

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PAMPHLETS

The American Medical Association, many of the private national health organizations named on pages 793–794, the United States Public Health Service, and numerous departments and divisions of the Federal Government and the various States, publish pamphlets available either free or at small cost.

JOURNALS

Hygeia, the Health Magazine. For laymen. Published monthly, by the American Medical Association, 535 North Dearborn Street, Chicago, Illinois.

Mental Hygiene. Published quarterly, by the National Committee for Mental Hygiene, 1790 Broadway, New York City.

LIBRARY

The National Health Library is maintained by the National Health Council, at 1790 Broadway, New York City. Its facilities are available to members of constituent organizations, as given in Table 3, pages 793–794. It includes 6000 volumes and 30,000 pamphlets. More than 500 medical and public-health periodicals are received regularly from all parts of the world.

Members from all over the country avail themselves of the privilege of borrowing books, and persons who are not members of the constituent organizations may do so by paying a small annual fee.

INDEX

[Proper names of historical significance are in italics.]